DOCUMENT RESUME

ED 197 948 SE 033 915

TITLE	Meeting Energy Workforce Needs. Proceedings of the National Conference on Determining Education and Training Requirements (Washington, D.C., February, 1980).
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Energy and Education Action Center.
PUB DATE	Feb 80
NOTE	351p.: Contains marginal legibility in Tables and Charts.
AVAILABLE FROM	Information Dynamics, Inc., 111 Claybrook Drive, Silver Spring, MD 20902 ($20.00).
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	*Educational Assessment: Employment Opportunities: *Energy: Government School Relationship: Job Analysis: *Job Training: *Labor Force Development: Labor Needs: *Occupational Information: Technical Occupations: *Trend Analysis

ABSTRACT

Presented are the proceedings of the National Conference on Meeting Energy Workforce Needs, held in February, 1980 in Washington, D.C. The conference program focused on: (1) the best available assessments of future job opportunities in energy related occupations: (2) programs and curricula available for occupational training in areas where growth in energy career opportunities is projected: (3) capabilities of the nation's schools, colleges, and other training facilities to meet anticipated needs: (4) guidance and counseling efforts needed to help students and workers to understand potential opportunities and required aptitudes and training: (5) assessment of energy related jobs for minorities and women: and (6) efforts to improve linkages between educators and industry, government and labor to assure best use of educational and training resources. (Author/CO)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS
MATERIAL HAS BEEN GRANTED BY
Robert Teittler, President
Information Dynamics, Inc

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)."

ED197948

Proceedings of the National Conference on

MEETING ENERGY WORKFORCE NEEDS

Determining Education and Training Requirements

February, 1980—Washington, DC

Sponsored by The U.S. Office of Education's Energy and Education Action Center

In Cooperation with: American Association of School Administrators, American Society for Training and Development, American Vocational Association, Association of Community and Junior Colleges, Education Commission of the States, Forum for the Advancement of Students in Science and Technology, National Council for Resource Development, National Energy Foundation, National League of Cities, National Urban Coalition, U.S. Department of Energy and U.S. Department of Labor

SE 033 915

Library of Congress Catalog Card No.: 80-81776

Copyright © 1980 by Information Dynamics, Inc.
All rights reserved. For further information:

Information Dynamics, Inc.
111 Claybrook Drive
Silver Spring, Maryland 20902

Manufactured in the United States of America

CONTENTS

Foreword vii

Education's Role in Meeting Energy Workforce Needs
William L. Smith 9

Energy Development—Is There a Need for More People?
Norman Seltzer 14

The Future Workforce Requirements in Energy Producing Industries
Neal H. Rosenthal 22

The Politics of Energy and Jobs
Richard L. Grossman 28

Solar Energy Employment
Girard W. Levy 38

Training for Solar Jobs: A Follow-up of California CETA Programs and Their Graduates
Barbara A. Burns, Bert Mason and Gail V. Mikesa 45

Occupational and Training Requirements for Expanded Coal Production
John B. Ostbo 67

Preliminary Forecast of Likely U.S. Energy Consumption/Production Balances for 1985 and 2000 by States
J. F. Gustaferro 75

Update of Employment Trends in Nuclear Power Industries
Larry M. Blair 90

Forecasting Construction Labor Requirements for Powerplants
William F. Hahn 109

Strengths and Pitfalls in Doing a Needs Assessment in Emerging Energy Technologies
Marcus C. King 118

A Model Needs Assessment
Michael J. Nastick 125

Renewable Energy and Employment: Decentralized Energy and Jobs in the 80's
Scott Sklar 135

A Profile of Energy Education Programs
Jack Seum 141

Employment, Education, and Recent Legislation
Wayne Stevenson 157

Vocational and Adult Education—Energy and the 80's
Daniel Dunham 174

Broad-Based Curriculum for Training Energy Conservation-and-Use Technicians
Michael E. Blackmon 181

Project EFFECT: Energy for the Future: Education, Conservation, Training
Gail S. Dowty 194

Energy Education and Elementary and Secondary Schools
Shirley J. Hansen 206

Energy and Jobs for the Future
Rafael Fermoselle 212

Training Technicians for Coal-Fired Power Plants
Bonnie F. Rinard 220

Training Programs of a Public Utility
Sondra J. Gillice 232

Energy, Education and Economic Development
Ann M. Martin 236

Energy Impacts on Our Health Delivery System
Gordon W. Berg 248

Training Programs and Advanced Education in Solar Energy
Kevin O'Connor 258

Workforce Training Implications of an Empirical Survey of Energy Curricula
Ethel Simon-McWilliams 280

Counseling for Career Opportunities in Energy-Related Industries
Mayme R. Crowell 290

The Development and Dissemination of Career Information for Students/Workers
Russell B. Flanders 307

Orienting America's Youth Towards Future Energy Careers
Ann L. Borden 313

Career Education and the Energy Crisis
Kenneth B. Hoyt 321

Opportunities for Women in Energy
Mary Lou Randour 327

Linkage Efforts Among the States
Edith M. Petrock 334

Industry and Linkage Building
George H. Lawrence 340

Improving Linkages Among Governmental Organizational Entities
Wilton Anderson 346

FOREWORD

Will the nation have the trained workforce required to implement actions to deal with the energy crisis looming for the 1980's and beyond? With the administration's stepping up of efforts to address energy problems in the fall of 1979, the need to examine education and training capabilities to meet foreseeable needs becomes imperative.

In accordance with its mandate to serve as the point of focus for a Federal government educational response to the challenge confronting schools, colleges and business and industry created by emerging energy realities, the U.S. Office of Education's Energy and Education Action Center (EEAC) sponsored this national working conference in February 1980 in cooperation with other federal agencies and private groups. These included: American Association of School Administrators, American Society for Training and Development, American Vocational Association, Association of Community and Junior Colleges, Education Commission of the States, Forum for the Advancement of Students in Science and Technology, National Council for Resource Development, National Energy Foundation, National League of Cities, National Urban Coalition, U.S. Department of Energy, and U.S. Department of Labor.

The conference program focused on

- The best available assessments of future job opportunities in energy-related occupations.
- Programs and curricula available for occupational training in areas where growth in energy-related career opportunities is projected.
- Capabilities of the Nation's schools, colleges and other training facilities to meet anticipated needs.
- Guidance and counseling efforts needed to help students and workers to understand potential opportunities and required aptitudes and training.
- Assessment of energy related jobs for minorities and women.
- Efforts to improve linkages between educators and industry, government and labor to assure best use of education and training resources.

Nationally recognized authorities were invited to present papers in their fields of expertise. It is these papers which comprise the chapters of this publication.

Wilton Anderson
Director, Energy and Education
Action Center, U.S. Office of
Education

Education's Role in Meeting Energy Workforce Needs

William L. Smith, U.S. Commissioner of Education,
Department of Health, Education, and Welfare,
Washington, DC

In early January, President Carter announced a proposed comprehensive program to help America's youth—particularly disadvantaged minority youth—meet unique and serious obstacles to employment in the 1980s. When fully implemented in 1982, this program, together with current programs, would provide almost $6 billion for basic education, work experience, and training for an estimated three million young people. About half of those helped would be junior and senior high school students. The remainder would be young people out of school, including dropouts and others who experience serious difficulty in finding and keeping jobs.

In cooperation with the youth employment efforts of the Department of Labor, the Department of Education will focus upon:

- basic skills for low-achieving youngsters, including help for students with limited English-speaking ability;
- school-wide planning, with the active involvement of teachers, parents, employers, and the community;
- the use of the link between work and classroom learning as a way to motivate students to stay in school; and
- a major role for vocational education in preparing young people for work.

Commitment to the workforce-related education and training needs of our Nation's youth is reflected in the Fiscal Year 1981 Budget Request for education. The proposed budget includes an increase of 7 percent, or about $1 billion over the current fiscal year.

Clearly, these developments underscore the timeliness of this conference. We must see our task as twofold. First, we must demonstrate to our Nation's young people—particularly those in minority populations—that a better education can mean better jobs and fuller participation in our national life. Second, we must assure ourselves that, in carrying out the first task, we will also meet the Nation's workforce requirements, which are affected almost daily by the increasing complexity of the energy crisis.

What are the realities we must face in this crisis? I shall cite several:

- throughout the world, energy is being consumed much faster than the supply can be replenished;
- continuous depletion of energy resources is producing a critical situation that will bring about marked changes in the life-style of the world's population;
- whether the crisis we face becomes more or less severe will depend on current and future decisions we make regarding our use of energy and technology, as well as our habits of consumption;
- peaceful and orderly transition into a new energy age will depend on an increased realization and understanding that each individual is a member of a global community with a common plight and common fate—a community inextricably bound by the energy decisions and actions that will have to be made and the human values which serve as their basis; and
- global viability and survival is dependent upon an understanding of, and appreciation for, nature and her laws.

What do these realities mean from the standpoint of those of us who are educators, trainers, and even employers of the workforce that will be required to fill energy-related jobs in the years ahead? They suggest that we must, at the outset, adopt a macro rather than a micro view of the world we live in. We must understand distribution patterns of global resources. We must appreciate the Nation's strategic vulnerability to petroleum and gas supply interruption. We must ask ourselves whether, for lack of initiative and enterprise, we are forced to choose between escalating consumption or economic stagnation and recession—and we must provide answers to this question.

In view of the very real problems created by the energy crisis, and in view of the attendant implications for education, I cannot overemphasize the significance of this conference, and your presence here. Nor can I overstate the timeliness of the conference.

Therefore, as U.S. Commissioner of Education, I am pleased to have this opportunity to open this conference and offer a number of suggestions.

First, I would suggest, as you involve yourselves in the conference, that you keep in mind the appropriateness of an observation made by the noted historian, James Truslow Adams:

> "There are obviously two educations. One should teach us how to make a living, and the other how to live."

Second, let us recognize that education is now at a critical juncture. We must decide whether we will lead the way out of the energy crisis or act merely as followers, allowing ourselves to be at the mercy of events and circumstances.

As educators, we must recognize that we ourselves are at a critical juncture. We must ask ourselves this question: Do we take the lead or follow the lead when we discharge our responsibilities as teachers, counselors, administrators, validators of curricula, certifiers of competency achievement, and ultimately employers? Are we fulfilling our responsibilities?

When I note that the agenda of this conference includes job forecasting by utilization of economic trend data, technological supply/demand statistics, and so on, the question that comes to mind is this: How far do we go in taking the lead in actions affecting our Nation's energy future and all it connotes expressed in societal and economic terms? I know there is no easy answer to this question, for if such were the case, this conference would not have been necessary.

Third, let us recognize that we must be fully aware of the scope, capabilities, and potentials of modern-day technology. We must be in the business of developing, not debunking, proposed new technological approaches. We must view assessments of the current "state of the art" in energy, in terms of perceptions, practices, and results. We must accept, not disparage, the need for collecting, compiling, and communicating information about energy-related vocational activities nationwide.

Let us identify gaps in education and training-course context through institutional surveys, longitudinal follow-up studies of trainees for ongoing curricular revision, and determination of training adequacy based on performance requirements; and, through refinement of forecasting methodologies, to more accurately project undermanned or saturated occupational categories.

We must insist upon the opportunity to help evolve education policies at the Federal level in particular, and at the State and local levels in general. In this regard, we must be mindful of the opportunity to use the *Federal Register* for comment and to enlist the expertise of national, State, and local advisory groups in contributing to Federal policymaking in education.

My fourth suggestion relates to the changes the energy crisis is making in our society. We are in a state of transition. We are moving from an era of abundance to scarcity, from plentiful cheap fossil energy to scarce expensive energy. This fact is having a major impact on human values and attitudes. We are having to learn that we live in a conserver society and that we must make more prudent use of our available resources, and preserve the quality of our environment.

This transition period must of necessity permeate our education system and be reflected in curriculum, research, public service, and skill training. Awareness and knowledge of this transition must begin in preschool years and continue throughout adult life as part of life-long learning.

Added to all the problems I have enumerated are the unresolved problems of inflation, school dropouts, and declining pupil achievement. The impact of these problems will be felt more acutely by minority youth. But they are of such scope that they pose serious challenges for youth of all groups in America. Here are examples:

(1) Upward job mobility for youth will require a new path.

Service sector firms are white collar, office-oriented and technical. Communications and technical skills are considered the keys to advancement. This is in contrast to industrial firms, which allow people to achieve well-paying jobs by taking entry level jobs and then working their way up based on seniority and experience.

(2) The discipline of the workplace is changing.

Firms demand education and basic skills as a requirement for employment. They place a premium on independent initiative. The prototype product of an industrial firm has been the automobile; the prototype product of the service firm is the *written* report. Employees need education to get a job, to hold a job and achieve promotion. The ability to read and write is taken for granted in the service economy.

(3) There has been a dramatic increase in the number of employers who require a high school diploma.

In 1950, 34 percent of jobs did not require a high school diploma. By 1970, only 9 percent of jobs were available for teenagers without a high school diploma. Complicating all this is the fact—based on findings of a national survey—that personnel managers are not going to be willing to take risks, and many employers have lost faith in the quality of education. They have found many young people with diplomas who cannot fill out application forms correctly. They look increasingly for employee prospects who can add and subtract, and read and write. Most applicants in the 1980s will *have* to be able to read and write just to find a job, even when the job itself may involve rudimentary skills.

In light of these realities, let's be clear about why we are directing our attention to workforce issues. Let us start at this point. We must increase our level of cooperation and collaboration. We must, above all, communicate with each other about our doubts, failures and successes. Sir Isaac Newton said it best:

> "Men build too many walls and not enough bridges."

This leads me to my final suggestion—which I present to you in the form of a charge to this conference:

1. Each participant should depart from this conference with a clear sense of having *actively* participated in addressing some or all of the issues inherent in the topics which comprise the conference agenda;
2. Each participant should strive to take away an increased level of awareness of the gaps that still remain between the way we are going about conducting our day-to-day education and training business and the options available to aid us in revamping our approaches and re-ordering our priorities as necessary; and
3. Each participant should obtain a greater awareness of, and a deeper appreciation for, the magnitude of the job that lies ahead—a job that requires all of us to be responsible for assuring that this Nation has the workforce available to retain its national viability, while at the same time assuring that each individual is adequately prepared to enter the workforce with equal opportunity to reap the benefits that are derived from his or her education and training in the work place.

Finally, I would urge that our thoughts and deeds reflect our clear understanding of the goals of education as it relates to training and work. I would suggest that some consideration be given to a thought once offered by John M. Mason:

> "The aim of education should be to convert the mind into a living fountain, and not a reservoir. That which is filled by merely pumping in will be emptied by pumping out."

Energy Development—Is There a Need For More People?

Norman Seltzer, Chief, Manpower Assessment Program, U.S. Department of Energy, Washington, DC

INTRODUCTION

Any assessment of the nation's requirements for trained persons possessing a variety of knowledge and skills to perform energy-related tasks should be viewed generally against the background of current conditions and an assessment of the energy outlook for the future.

The nation's objective, as stated by The U.S. Department of Energy and the Administration, is that within the next decade we must cut our dependence on foreign oil by 50 percent, while maintaining a strong economy. Considering all of our current difficulties, we have in the vernacular "got quite a ways to go." It is clear that no single energy source, no single restraint on demand, and no single technological innovation can resolve all our current energy problems.

Let me mention briefly what the Department of Energy current year programs are to both limit demand for energy and to increase the availability of supplies from major energy sources.

On the demand side, DOE's fiscal 1980 budget provides direct funding of over 800 million dollars, and proposed level of over 1 billion dollars in fiscal year 1981 for conservation programs. Both 1980 and 1981 budgets provide about 300 million dollars for conservation R&D activities in building and community systems, and the industrial and transportation sectors. Grants to state and local governments are currently funded at about $460 million and are scheduled to increase by 25 percent next year. These grant activities include, among other items, energy audits and conservation measures for schools and hospitals, and weatherization assistance for low income persons, particularly those who are elderly or handicapped. There are a number of other conservation regulatory programs which could well also have an impact on your concerns at this conference.

On the supply side, we are all aware that there must be a continuing effort to develop economically and environmentally acceptable substitutes for oil and petroleum. Although the prime responsibility for the development of alternate energy sources lies with the private sector, the Federal Government does play an important role in meeting that responsibility. This includes a substantial investment in direct federal expenditures for research and development, and efforts to remove barriers to the commercial use of developing technologies. The current year budget for these activities is about 3.7 billion dollars and is estimated to increase about 10 percent next fiscal year. Funding for every energy resource is scheduled to increase with the exception of nuclear fission. This also includes increased funding for environmental programs and support for basic energy research programs to provide the scientific base for energy technology developments.

Either directly or indirectly, these financial support programs plus others which provide financial incentives to industry and consumers, and certain regulatory programs, do or may have an effect on the utilization of persons for the energy work force and the potential for education and training.

As a matter of background, I would like to outline what the efforts of the Manpower Assessment Program have been.

Manpower Assessment Program

This program was first set up about 4 years ago as a result of a legislative mandate in the Energy Reorganization Act of 1974 which established the Energy Research and Development Administration (ERDA). Because of what I believe to be the wisdom of some educational organizations, Congress saw fit to include a provision which called for ERDA to be responsible for assuring an adequate supply of well trained persons to carry out required energy-related activities by, among other things, undertaking the collection, analysis, and dissemination of the necessary manpower supply and demand data. That mandate was subsequently incorporated into the legislation establishing the Department of Energy.

I was given the privilege of developing this program; perhaps "challenge" is a more appropriate term since their was little staff and a zero-based budget. A limited amount of funding was provided over the next few years. Within our limited resources we have managed to support a variety of efforts which have and hopefully will continue to provide useful information to a variety of consumers—in the federal government, to state and local governments, to the educational community, to industry groups and labor unions, and to individuals seeking to learn more about potential job opportunities in the development of energy technologies and conservation activities.

We have over the past several years, to cite a few examples, supported projects to:

- Develop and maintain (in cooperation with the Department of Labor) a construction labor demand system to forecast skilled craft requirements for constructing energy-related facilities on a national and regional levels.
- Develop a design for a Comprehensive Energy Manpower Information System.
- Develop estimates (in cooperation with the National Science Foundation) on the number and characteristics of recent science and engineering graduates entering the energy work force.
- Develop estimates of the employment levels and occupational profiles in developing solar and geothermal technologies as well as preliminary forecasts of future requirements.
- Analyze (again in cooperation with the Department of Labor) the reasons for past coal mine labor productivity declines as inputs for forecasting future personnel and training requirements.
- Develop estimates for occupational and training requirements to meet expanded coal production goals;
- Assess the potential impact of commercializing coal gasification systems on labor requirements for various skill categories; and
- Estimate the requirements

Because of severe budgetary constraints, we have been extremely limited in the extent to which we have been able to build on our previous efforts. But I am hopeful that the future will bring improvement.

Job Destruction—Job Creation

I find I have some uneasiness about my assigned topic "Energy Development—Is There a Need for More People?" It is, of course, a basic question and an important one, but if you will bear with me I propose to note first some aspects of the energy-employment relationship which might not otherwise be emphasized in a book which focuses on energy workforce needs. If we define energy developments in its very broadest sense, then the fact is, that there is job destruction as well as job creation as a result of such developments, and in order to better deal with the more people question, we should know something about both aspects.

We don't have to look very far these days to come across news about the impact of energy on jobs. For example, several weeks ago, on the very day I started to think about what I might say here today, two stories appeared in the financial pages of the Washington Post. The first story headlined the fact that General Motors sales and earnings had declined sharply during the fourth quarter of 1979. The body of the story had some surprising news. It noted that for the first time in a number of years, GM was not the world's largest corporate giant. In 1979, that honor went to Exxon. The energy crunch giveth, and the energy crunch taketh away. Employment implications? Of course, a decline in jobs at General Motors and some more jobs at Exxon—that's because the automotive industry is more labor intensive than the petroleum industry. Job destruction and job creation. Although I don't have specific data, it's probable that the exchange in rank between the two energy related corporate giants resulted in job destruction—a net loss of jobs and that the size of that loss was relatively large.

Elsewhere on the Post's financial page that day was the second story. This was headlined "Stand-by Plan is Unveiled for Conserving Gasoline." You will be reading in this book, as you have read elsewhere, about the job creating dimensions of conservation. The body of the Post's story, however, includes an aspect that is sometimes overlooked—one prominent feature of the proposed conservation plan is a shortened work week. If factories and offices are closed, more energy is conserved. Unfortunately, this may also mean less. This particular conservation proposal may result in less jobs.

Tempering Optimism

Now, I suggest that it would be well to keep these two news items in mind, both during the rest of my remarks and those included in the other papers. There is a need to temper optimism because as soon as we talk in terms of development, energy development in this case, we introduce bias in favor of optimism. There are always some new or changed jobs associated with new and emerging technologies (and at times even with the expansion of existing technologies because of other factors).

All emerging technologies have job creating dimensions, as do those industries and activities related to the development of those technologies. Scientists are involved in the basic research phase; scientists, and to a greater extent, engineers and technicians during the development stage; and during production and operations, technicians, craftsmen and other types of lesser skilled workers. Various new kinds of jobs sometimes seem to emerge, at least during the early, more primitive stages of development and production.

When we study the people implications of coal gasification or biomass conversion or conservation technologies, we are focusing on emerging technologies which have job creating implications. This information is important. We must have information about growing job families as a basis for more effective curriculum planning and career and vocational counselling. However, the fact that some job families are growing or changing does not answer the whole of the "more people" question. For this purpose, we need to know the number of people displaced in industries like automotive which are hurt by the energy crunch. It is well to recognize that there are job destroying dimensions to conservation as well as job creating dimensions. As I indicated before, this is all too easily overlooked when we focus on development with its implicit emphasis on job creation.

Curriculum Planning Decisions

At this point, I would like to focus briefly on two aspects of job creation which I believe are occasionally overlooked. These are of immediate consequence to planners in the educational community. The first is an obvious point which I believe needs to be continually reemphasized. New jobs created by new technologies are often short-lived. They tend to disappear quickly as new industries evolve. I believe it's well to keep the ephemeral nature of new jobs in mind when making curriculum planning decisions.

I mentioned that on occasion, new jobs emerge during the earlier, more primitive stages of production. By this I mean the time in the life of an enterprise when goods are produced under what amounts to handicraft conditions.

During this stage, engineers and technicians frequently do the production work. Every installation is unique. For example, early solar space heating systems were probably individually designed by an "engineer" (who is called a solar engineer—new job); the new engineer worked with an assistant in fabricating collection panels (the assistant, of course, is a solar technician—another new job). They were joined by still another new specialist who handled the installation of the system. This individual might be called a solar space heating installation specialist. I think you get the idea. Within several years, however, the industry matures and the production process is rationalized.

It then develops that the solar engineer is a mechanical engineer who had designed a couple of solar systems and acquired all the new knowledge needed. It develops that systems could be fabricated by semi-skilled operators and that installation and maintenance may require about the same level of skill and knowledge previously possessed by heating system installers.

The vast number of dramatic "new" jobs and the highly publicized requirements for many new types of skills and knowledge requirements has changed. Given an expanding market, the solar technician trained through the new forward looking program will, of course, find a job, but there is now competition from the old fashioned sheet metal worker and plumber who can probably do the same job with some short-term add-on training.

This leads me directly to the second frequently overlooked aspect of job creation. Relatively little, to my knowledge, is completely new in the job task world. By this, I mean that for the most part present professionals or technicians pick up (on the job) the modified skills or additional knowledge they require to meet the demands of the technology—often without requiring additional formal study.

In developing this point, our office sponsored during the past year a project in California focusing on manpower requirements for energy conservation—A case study. California legislated a solar tax credit in 1977 and energy conserving building standards in 1978. What was the employment impact? Well, the study found—"No evidence of increased demand for architects, engineers or contractors" but rather "a modest change in the mix of knowledge some designers, builders, and inspectors . . . need." Similarly (and again I quote) "solar installations (involved) a new increment to existing trades, requiring only little additional knowledge." It is probably true that similar observations will occur about the new skill and knowledge required for many of the emerging technologies. The incremental knowledge needed may be important, but modest in scope.

Perhaps more to the point, this highlights the questions curriculum planners should be asking instead of the one that's too often asked in connection with new technologies. It seems to me that the question for the curriculum planner is not necessarily, for example, "Should we counsel more people to become engineers?" it is perhaps "Do our programs provide those new areas of skill and knowledge appropriate to the needs of engineers who will work in these new industries?" This is not necessarily an easier task, experience indicates it is frequently easier to start something all new than to change something in place.

The California study emphasized an obvious fact that is relevant in this context. That has to do with what the authors term the dynamics of the "non-formal" sector of education. The study investigators found that new skill and knowledge needed is most frequently learned through briefings and bulletins by manufacturers, special short courses by professional associations and through other channels of communication outside of the established educational structure. This is the system they term the "non-formal sector of education." With this in mind, one important challenge to the formal education sector is to establish and maintain relationships so that those of you involved in the formal sector can learn quickly about those incremental units of new information and to move to integrate them into courses or programs for new practitioners when in your judgment these incremental units have intellectual merit.

Another simplistic example is that geothermal energy production requires "drillers." Our office sponsored a study of this very infant industry which indicates that most driller personnel come from the petroleum industry. But there are differences in the technology as relates to the types of material and techniques involved in carrying out drilling operations.

I would say that the challenge here is to identify and teach the differences; not necessarily to assume that the drilling job is either entirely the same or entirely different. The information about these changes is presently in the heads and arms of the people in the field. The "non-formal" sector people are on site and become aware of differences. The formal educators need conduits so that they can identify and characterize these differences.

The Educational Challenge

I believe that the development of new technologies like those associated with energy pose a real challenge to the educational community, but the challenge is not necessarily, as I said, to design all new programs for more people. In many cases, the challenge is more subtle and therefore more difficult. It requires information about tasks that may be disappearing as well as those being created. That's one definition of change.

The challenge is to have the communications channels in place so that knowledge of change can be learned quickly both from assessment studies and from the "non-formal" sector, the practitioners in the field. The challenge is to teach about these changes in the context of present programs where appropriate—not necessarily to expend scarce and valuable resources on completely new programs which may be ephemeral. And the challenge is to provide meaningful information so that students and other job seekers will have a reasonable basis for participating in the energy workforce and help achieve our energy goals.

The Future Workforce Requirements in Energy Producing Industries

Neal H. Rosenthal, Bureau of Labor Statistics, U.S. Department of Labor, Washington, DC.

INTRODUCTION

Through my long experience in developing occupational projections, I have often been involved with questions concerning the demand and supply of workers in fields that are the focus of national interest. Over the years, these concerns have dealt with environmental protection, defense, space, care of the aging, health, and for some time now energy. My association with efforts to identify needs in these fields have been very interesting—as you would expect it to be when one is involved with a national concern—but from a technical viewpoint it's been very frustrating. For an economist and manpower analyst to come to conclusions, data are required that allow analysis of the area of concern. Unfortunately, available data generally are not in a form that facilitates the required analysis.

Historical data on employment, which are the basis of looking at the future demand, generally are in the form of industry employment or occupational employment. Data on fields of work that cross industry and occupational lines and encompass only parts of industries and occupations are very difficult to obtain. Energy related work is one of these fields.

One area is clear, however; workers engaged in producing energy can be identified because statistics are available on employment in the energy producing industries. That subject is the focus of my remarks.

Specifically, the energy producing industries that I will discuss include crude petroleum and natural and liquid gas extraction (including oil and gas well drilling), coal mining, petroleum refining, and both electric and gas utilities. Not included are the activities associated with solar energy, synthetic fuels, or other unconventional energy sources that are largely under research and development. Also the construction of electrical generating plants and petroleum refineries is not included and the distribution of petroleum and coal products is not included (the distribution of gas and electricity is included). Workers in Government concerned with regulating energy and developing energy policy and workers in industries that are devising more effective and cost efficient ways of using energy also are not included. I am not aware of any definitive estimates of workers encompassing fields that are not included in the energy producing industry as I defined them. There is therefore no summary total of the number of workers engaged in "energy."

In terms of questions related to manpower in energy there are several that we would like answered to develop policy, plan education programs to meet policy objectives, and for career guidance of young people who hear that energy is the field of the future.

Among these questions are: What proportion of total employment is engaged in producing energy? How fast are the energy producing industries expected to grow relative to the economy as a whole? What is the occupational composition of jobs in energy?

With answers to these questions, work can begin on the tough questions: What are the implications of these data on the prospective supply and demand of workers in the field of energy? Is it necessary to support additional training or revise the type of training now in existence? What effect will the manpower picture in energy producing industries have on their industries and how do other industry prospectives and the prospective for the overall economy affect energy manpower?

Background

To understand where we are and where we are going in the energy producing sector of the economy, it's important to know where we have been. Overall, energy producing industries currently account for about 1.6 percent of total employment. Within the energy producing sectors, significant shifts have occurred since the late 1950's. For example, coal mining employment declined sharply between 1958 and 1967 (the decline started even earlier), but since then has shown a rather dramatic turnaround. The number of jobs in coal mining has increased by about 81,000 or by 53 percent from 1967–1977. Most of this growth occurred in the deep labor intensive mines in the Eastern States. Western coal production is a small, although growing proportion of total U.S. production, but employment growth is not as pronounced because these mines are predominantly the less labor intensive strip mines.

In all crude petroleum and natural and liquid gas extraction industries, including oil and gas well drilling, employment declined rather sharply from the late 1950's until the early 1970's. Since then, employment in these sectors has increased. Within oil and gas well drilling, employment growth averaged a very rapid growth of 69 percent from 1973–1977, a growth of nearly 100,000 jobs.

Employment in the other energy producing industries showed little change in recent years. Electric utilities grew moderately from 1969 to 1973, but since then have experienced almost no growth. Gas utilities were virtually at the same level in 1977 as in 1958 with little fluctuation between. Petroleum refining declined from 1958 to 1967 and has increased some since that time, but has not returned to the 1958 level.

Overall, employment trends in energy producing industries can be summarized as follows:

1. Employment in energy producing industries is a small part of total employment.
2. In several energy producing industries employment declined from the 1950's through the late 1960's, stabilized and began increasing.
3. Individual energy producing industries experience different growth patterns as one type of energy appeared to be substituted for another because of changes in relative prices and because of other factors such as supply constraints and regulations.

Occupational Distribution

Let's look at the occupational distribution of the energy-producing industries. Each of the industries has a somewhat different occupational structure because of the different activities performed. For example, in coal mining, engineers and scientists each comprise less than 1 percent of the industry's total employment, but each of these occupational groups accounts for 4 to 5 percent of employment in the crude petroleum and natural gas extracting industry. In coal mining, operatives account for nearly one-half of total employment whereas in electric and gas utilities they account only for 7 percent of the total.

Compared to the economy in general, the proportion of professional and technical workers, clerical workers, and laborers in the energy producing industries have about the same distribution. Managers, sales workers, and service workers make up a significantly lower proportion of the total in the energy producing sector, whereas the proportion of craftworkers and operatives is much higher.

Among detailed occupations in the energy producing industries, the supply-demand situation can be affected by the proportion of workers in the industry to the entire economy. As I indicated earlier, energy producing employment as a whole makes up a small, 1.6% of total employment. However, energy producing industries account for about 6 percent of all engineers, nearly 60 percent of all geologist and geophysicists (excluding those teaching in colleges and universities), 5 percent of engineering and science technicians, 4 percent of all craftsworkers, and 80 percent of all mine operatives which accounts for all the coal miners. It is in these occupations that supply-demand problems caused by a changing energy picture would be most significant. If we look at the past, the only significant problems faced by the energy producing industries that I could identify going through the limited literature is for coal miners, earth scientists, and engineering. Only in engineering is this situation related to economy wide problems because other industries do not utilize significant numbers of miners or earth scientists.

When we get to problems of training therefore it is only in those fields of work closely tied to the work in an industry that special training becomes important. For the vast majority of workers in the energy producing industries, the training is no different from workers in comparable jobs in other industries. These include clerical workers, sales workers, truck drivers, accountants, laborers, and craftsworkers, which account for the overwhelming majority of workers in the energy producing industries.

Future Projections

Let's look at the future. The Bureau has developed projections of workers by industry and occupation to 1990 through an economic model tied to a series of assumptions. Alternative models have been developed based on different assumptions, of which I'll concentrate on what is called the base case. Some of the general assumptions made are that unemployment will decline to 4.5% in 1990 gradually through the period. Thus, we are talking about a full-employment economy in 1990. It is also assumed that there will be a slow recovery in productivity, with a slightly faster rate of growth in the latter part of the 1980's than during the first half of the decade. Perhaps the major assumption for our discussion today is that higher prices for energy will not act as a constraint on aggregate growth (at least beyond what is already captured in the productivity growth), nor will an energy program alter significantly the supply demand balances in energy in the time horizon used in these projections. At the industry level, however, the mix of fuels used to meet energy needs is projected to change and thus affect employment requirements.

Within this model, total employment in the private sector of the economy was projected to increase by 28.8% between 1977 and 1990. It may surprise you that employment in the energy producing industries as a whole is projected to increase by only about half that rate, by 13.5%. Within the energy producing sector itself, however, widely different trends are projected. Coal mining is expected to have the greatest growth of any energy industry, about 50%. Oil and gas well drilling and electric utilities have projected increases between 20 and 25 percent, small growth is projected in crude petroleum and natural gas extraction, but employment in petroleum refining and related products is expected to decline as productivity growth has a great impact, and gas utilities employment is expected to decline along with declining output.

Thus, although employment in energy producing industries is expected to have what could be described as moderate growth, this industry group cannot be described as having a boom, except perhaps for coal mining. The prospective growth of employment in occupations key to the energy producing industries, therefore, should not create pressure on the available supply of workers except perhaps in coal mining where the number of miners required is expected to grow rapidly. On the surface at least this appears to be the only significant potential manpower problem.

Although the title of my remarks only concerns the energy producing industries, I would like to deviate a little to a discussion of some other areas of work within the field of energy. Throughout this book you will read presentations on other areas of work within the field of energy. Construction of power plants, solar energy, and training, is discussed. There are indeed many workers engaged in such activities, and in some areas there are some numbers attached to a particular area. Yet there are some things about these fields that should be kept in mind in terms of training requirements and career counseling, which are major subjects of this conference.

Those who are, shall we say, out in the field developing and offering training should be wary about expanding training programs that relate to solar energy, coal liquefaction, geothermal energy, and other, shall we say, exotic fields. These exotic fields have appeal to training officials of course. They are new and energetic training officials desire to be in the forefront of new and energy fields. Yet, I would say that caution should be the watchword. Most work in these fields is in the research and development stage and requires few workers with specialized training for production operations. Until they move out of the laboratory into commercial application, large numbers of workers will not be needed and training if provided may not provide trainees with employable skills. From a manpower prospective, solar energy systems set in residences and buildings is one of the few new areas requiring workers; but it involves skills found in workers already trained—plumbers, pipefitters, and sheet metal workers. There may be no need to establish new programs, although in some localities there may be a need to expand existing programs.

Similarly, construction of power plants requires the same basic skills needed to construct other structures. The skills of clerical workers, accountants, truck drivers, are also similar. The question becomes: Are training needs really different for the vast majority of workers engaged in energy activities? Clearly the training of some is different and specialized training is necessary. The question that needs to be answered here is what are these fields, how large is the prospective for training so specialized programs are not set up which train workers far in excess of the number that can obtain jobs.

SUMMARY

In other fields that are not specialized the question is: Should some energy related training be included with the regular training so those completing training can be better prepared for energy related work if they choose to find a job there rather than in another field. This of course leads to the area of vocational guidance. We must develop materials that places the field of energy in the proper perspective for young people in terms of job opportunities. Clearly the field of energy is important. Young people should be provided with information that enables them to be aware of opportunities in the field of energy. Yet it would be unfortunate if large numbers of young people prepared for a career in energy and only a few were able to find work in the field.

The Politics of Energy and Jobs

Richard L. Grossman, Environmentalists For Full Employment, Washington, DC

INTRODUCTION

Obviously, energy is necessary for the functioning of our economy, for our well-being, and for jobs. And just as obviously, the energy technologies in which large investments are made are where the bulk of energy-related jobs will be. But our energy future is currently dependent upon multinational energy companies, volatile foreign affairs, and complex and diverse political forces in the U. S. It is consequently not easy to predict the focus of tomorrow's major energy investments, and therefore to know which energy-related occupations people should be preparing for today.

I recognize that educators and trainers who are responsible for helping the nation meet its workforce needs are in a difficult position. What I want to suggest here is that you might find it useful to acknowledge the very *political* nature of energy issues; to understand the manner in which jobs have traditionally been treated by energy policy makers (either as a blackmail weapon, or a total afterthought); to consider yourselves as *actors* in this situation, not bystanders awaiting directions or orders from somewhere on high or far away.

I find that energy controversies revolve about the following fundamentals:

1) how much energy do we need/want?
2) what kinds of energy technologies and systems do we need/want?
3) what kinds of control/ownership do we need/want?
4) who will decide these issues, and by what process?

Energy Policy

Until 1973—and only slightly less so since then—energy policy in this country has been made by relatively small numbers of men: those on the Joint Atomic Energy Committee of Congress; executives at utilities, banks, and oil companies; a handful

---

The author wishes to acknowledge the work of colleagues Leh Rodberg and Gail Deneker upon which portions of this paper are based.

of appointed officials in the executive branch. These men and their institutions have enjoyed political, economic and technological control over energy. Quite naturally, they are reluctant today to give up what have been financially- and psychically-profitable endeavors. Accordingly, corporate energy interests, along with most industrialists, financiers and government agency leaders, are vigorously urging rapid expansion of energy production. The energy systems they recommend are the ones which best serve their needs. These happen to be large in scale, technologically complex, costly, wasteful, inefficient, environmentally destructive, and dangerous to industry employees and the public. They are also systems which are closely tied in with grave foreign policy issues—e.g., with nuclear proliferation and plutonium recycling, and Persian Gulf oil.

Most proponents of investment in these energy sources (nuclear fission and fusion, synthetic fuels from coal, greatly expanded coal-fired electric generation) concede that such development exposes employees and the public to a variety of dangers. But, they contend, there is absolutely no other way to meet the nation's energy needs for a strong economy, and for sufficient numbers of jobs—both in the energy industry and throughout the nation.

Accordingly, energy profiteers have vigorously sought to persuade the public that continuing energy expansion—as determined and controlled by them—has been the springboard to economic growth, the good life and jobs. And they have focused their message at particular constituencies (such as labor and minority groups) and at regions, making clear that pursuit of technologically delicate, dangerous energy programs is required for these groups to be able to share in America's largesse. And they seek to portray those who dare criticize their energy programs as being anti-job, anti-progress, and anti the particular constituency or region the energy conglomerates happen to be pandering to or blackmailing at any given moment.

It is not difficult to see why industry in general has promoted the myth about energy growth and economic growth: industry has been able to profit smartly by replacing workers with energy—energy purchased at very low rates from an ever-expanding energy industry which has been accumulating ever-increasing profits. The small consumer has been picking up the tab: industries traditionally have paid *less* than individual consumers for each unit of energy used. In addition, by bearing most of the environmental, disease, job dislocation and social costs associated with energy development, and by paying for substantial government assistance to energy companies, the public has actually been subsidizing industrial use of cheap energy to replace human labor.

Thus, it has clearly been in the interests of energy producers and major energy users to keep the public in the dark about energy supplies, production, expansion and use. From their standpoint, it has made sense to dig up their tired old threats about job loss and economic depression should they not get their way. That "blackmail" strategy has been used with much success in other political battles—against populist candidates for office, against child labor laws, unemployment insurance, workers compensation, the minimum wage, labor union organizing, occupational and environmental health legislation.

The Advantages of Energy Efficiency

But since 1973, Americans have had an education about energy. More and more Americans are understanding that the multinational energy companies' energy policies have been inadequate, and are suspicious of programs for tomorrow which promise more of the same. They see the compelling evidence that *increasing energy efficiency* and development of renewable energy sources can promote economic growth, create jobs, and protect health and the environment. They have seen that the supposedly sacred link between energy and economic growth has been broken (and that its validity even prior to 1973 is open to serious question.) They know, for example, that in 1978, Americans consumed only about 1.9% more energy overall than they did in 1977, but that the economy expanded at more than twice that rate. As a leading oil economist for the Petroleum Industry Research Foundation conceded:

> People were saying [lower energy use] would lead to a stagnation of the economy, but it hasn't. It all makes sense now. It didn't [a few years ago].

With one-half of our energy now wasted, and tens of billions of dollars going abroad to pay for this waste, people realize what a vast resource, inflation-fighter and job creater energy conservation can be. And they see the sorry record of predictions regarding how much energy the nation needs to waste (Table 1), and wonder what the energy giants and their government supporters have been up to.

In addition, they are examining carefully the energy technologies being touted as our nation's only options. They are wondering whether nuclear power, synfuels, vastly-increased burning of coal, may not be too inefficient, too inflationary, and too destructive of the public health (as well as to workplace and

TABLE 1: Evolution of Approximate Forecasts of U.S. Primary Energy Demand in the year 2000 (in Quad/year = 10^{15} BTU/year)

	SOURCE OF FORECAST			
YEAR OF FORE-CAST	BEYOND THE PALE	HERESY	CONVENTIONAL WISDOM	SUPERSTITION
1972	125 Amory Lovins	140 Sierra Club	160 Atomic Energy Commission	190 Bureau of Mines Federal Power Commission
1974	100 Energy Policy Project (Zero Energy Growth)	124 Energy Policy Project (Technical Fix)	140 Energy Research and Development Agency	160 Edison Electric Institute Electric Power Research Institute
1976	75 Amory Lovins	89-95 Frank von Hippel, Robert Williams; Amory Lovins in Foreign Affairs	124 Energy Research and Development Agency	140 Edison Electric Institute
1978	33 John Steinhart (for 2050)	63-77 Committee on Nuclear and Alternative Energy Systems (Conservation and Demand Panel) for 2010 (I) (II)	96-101 Committee on Nuclear and Alternative Energy Systems (III) Institute for Energy Analysis - Alvin Weinberg	124 Ralph Lapp

* From "Getting Efficient", by Amory Lovins, [illegible], November, 1979.

natural environments) to be acceptable. They are turning instead to large investments in conservation, to proven solar technologies, and to rapid development of solar technologies almost ready to be utilized. At the same time, they are challenging the domination over the nation's resources and investment capital by the energy giants and utilities.

The energy giants respond with usual forecasts of doom and mass unemployment. The President of Westinghouse, Richard Kirby, described his position last November with precision:

> We cannot look to new sources such as solar, geothermal and wind. . . . They will help. They are important. But their economics are such that they are not coming fast enough or abundantly enough to do the job . . . or even begin to do the job. . . . The public must also be told that it will have to choose—from time to time and from place to place—between nuclear energy and some tough alternatives. Alternatives like inflation, higher unemployment, no economic growth, and national insecurity.

Because the energy giants are who they are (the principal multinational controllers of oil, coal, uranium, chemicals, plus the construction companies, the manufacturers of electrical generating equipment, the utilities, all working closely with the nation's leading banks, insurance companies and government agencies), many Americans who do not approve of the energy giants' policies nevertheless go along because they believe that the energy multinationals have us over the traditional barrel, and there is no choice but to throw in our lot with them.

Workforce Assessments

This is not the context in which you should make reliable workforce assessments, and plan your training efforts. I do have some suggestions:

1. Examine carefully the record of energy forecasters (see Table 1). Most forecasts were done by assuming energy growth would continue accelerating at the rates of the 1960's. Thus, in 1972, the Atomic Energy Commission was predicting (I refrain from saying hoping for) 160 quads of energy needed by the year 2000. The Federal Power Commission rang in at 190 quads, and the Sierra Club was into heresy at 140. But just two years later, ERDA (a successor to the AEC) came down to the Sierra Club's 140, while the Edison Electric Institute (the public relations arm of the private utilities) settled in at 160 quads. In 1976, ERDA had tumbled to 124; and just last month, the CONAES panel

of the National Academy of Sciences forecast a low range of 63–77 quads, and a high range of 96–101 quads.

It is clear that even in the lairs of the energy giants, considerable rethinking has been going on regarding how much energy will support a thriving economy. And the trend is definitely downward.

2. Examine also the growing body of data regarding energy, economic growth and employment relationships. Environmentalists For Full Employment and the Public Resource Center have just completed an analysis of more than seventy such studies. We found:
    - A. In relating energy requirements to future employment needs, the government has cavalierly accepted the contention of major energy producers that to support employment throughout the economy as well as in the energy industry, continued expansion of fossil fuels and nuclear energy is essential. However, the energy field has not been singled out by federal policy makers as a significant source of new jobs for the 1980's. And the effects of different energy scenarios on employment have largely been ignored.
    - B. There is growing evidence that emphasizing energy conservation and renewable energy is consistent with high levels of economic vitality in the economy as a whole and would lessen our need for scarce and costly conventional fuels (oil, gas, coal, uranium). Additional research is needed to show in detail how these measures could be introduced, what new industries would be created.
    - C. Numerous studies show net employment *benefits* from the introduction of conservation and renewable energy measures. Not only are jobs created in the conservation and renewable energy industries, but the reduced consumption of energy also produces a shift in consumer spending that adds jobs throughout the economy. Analyses that fail to take these factors into account perpetuate a bias against conservation and renewables.
    - D. Studies show that reduced purchases of conventional forms of energy, made possible by energy conservation measures and the use of renewable energy, can have significant employment benefits in many localities. Most regions of the country must import

their energy from elsewhere. By curtailing these imports and substituting conservation and renewables, localities can promote their own economic growth and create jobs at home. Again, these jobs will not be limited to the conservation and renewable energy industries, but will appear in the wider economy of the region as well.

E. Most employment impact studies of conservation and solar energy applications have concentrated on the residential sector. But conservation and solar technologies have valuable applications in the commercial, industrial and transportation sectors, where eighty percent of our energy consumption takes place and where significant energy efficiency increases have already been recorded. Failure to examine these areas represents a major gap in the research effort, and future employment impact studies should be expanded to include them.

F. Most studies which have looked at solar energy have dealt with conventional solar water heating systems—rooftop collectors, pumps, and water storage tanks. A few have dealt with wind systems and photovoltaic systems. (Since the ultimate technology that will be used to produce solar cells has yet to be developed or commercialized, these latter estimates are quite unreliable.) None has looked at biomass conversion systems that could collect municipal and/or agricultural wastes and convert them into electricity, alcohol, or methane. Yet biomass is likely to be an important part of our renewable energy future. The construction of biomass conversion facilities, followed by the collection of these materials and the operation of the facilities (as well as by the *production* of agricultural products having high energy yields), are likely to be rich sources of employment, in both urban and rural areas.

G. There is no evidence that the recent studies and analyses of energy-employment interactions have been a factor in Federal energy policy. Furthermore, to the extent that analytical studies are used as an integral part of Federal energy policy making, they do not seem to use frameworks or methodologies suited to illuminating the employment consequences of energy policies. In short, employment has not been a major factor in energy policy decisions.

H. Little attention has been directed to qualitative aspects of jobs in the energy field, to health and safety hazards posed to employees and their communities, and to the broader environmental impacts and social costs.

To be blunt, employment in the context of energy has gotten the shaft.

3. You should look carefully at what might be holding back widespread use of solar and energy efficiency technologies. Are the barriers technological, institutional, economic or political? Would changes in solar and energy efficiency financing, for example, dramatically alter their penetration? How much are questions of political and economic *control* over energy investments and hardware determining the extent, nature and timing of burgeoning solar/conservation industries, and the millions of jobs they would bring?
4. Look at a variety of recent trends: nuclear capital costs have been rising well above inflation rates. Orders for nuclear plants are being cancelled with increasing frequency. Opposition to multinational energy policies is increasing nation-wide, and assuming many forms: interventions with public utility commissions, lawsuits, occupations and civil disobedience, grass roots educational campaigns, individuals and communities turning to independent energy supplies and systems. There is over-capacity in central station electrical generation which is causing utilities considerable financial woe. And there is a rush for synthetic fuels which will create oil at about $60 per barrel or more—by a process which will wreak havoc upon the Western states, upon the health of its citizens, their environment, their water.

Disappointed in the energy giants, people are turning with growing confidence to a wide variety of renewable energy technologies for new supplies with which to fuel the economy.

5. You should consider the following: the record of major American companies involved with energy on job-related and consumer issues is atrocious. Despite their lavish and often heart-rending avowels of concern for jobs, union members, minorities and consumers, they have opposed legislation designed to assist these groups: the Humphrey-Hawkins Full Employment bill, the Labor Law Reform bill, the Common Situs Picketing bill, the Consumer Protection

Agency bill. They're fighting occupational safety and health legislation, and engaging in vigorous union busting (particularly against the building and construction trades). They've been steadily moving investments and jobs out of communities to other places in the U.S., and overseas. And they've been de-skilling jobs as quickly as they can. Their profits have shot up, but consumers are paying higher rates than ever. The American people are constantly being told by them that we must regard as "acceptable" higher and higher rates of unemployment. And finally, the energy industry, which has recently discovered great concern for minorities, has just about the worst minority hiring record of *any* industry in America.

6. Lastly, you should consider yourselves not observers in the energy wars—but as actors, as doers. Predictions and forecasts are useful only as far as they help people and organizations consider various actions they can undertake to fulfill or go beyond the predictions. You *can* set your own goals, and then work to make them come true. You can help put pressure on the Department of Labor and the Department of Energy to perform the kinds of analyses you would find useful. For example, it is almost one year since President Carter announced his goal of 20% solar by the year 2000. Yet the Bureau of Labor Statistics—which is responsible for examining what that would mean in terms of job training necessary and energy-related jobs—hasn't begun to take a look. Neither DOE nor DOL has tried to relate energy policy to the current employment situation. No analysis has been done which focussed on measures which could ensure that those who are currently unemployed would receive jobs in new or expanding energy industries. No study has sought to relate future energy policies to employment needs of particular regions of the country, or to examine policies and programs which would assist people to make job transitions. Finally, no study has sought to relate the job potential of energy policies to employment needs of low-income people, minorities and women.

SUMMARY

As long as we believe that the energy giants scorned will force us to freeze and starve—jobless—in the dark, we will continue to be at their mercy. And the best you will be able to do is gear your job training efforts to their whimsy, as well as to the caprice of foreign nations. But if you are interested in safe energy which the American people can control, so that we can have productive, socially-useful jobs which the American people can control, you need to help the nation make a major commitment to the creation of an energy-efficient, renewably-fueled economy.

To do this, we must have confidence that we have available a wide range of conservation and renewable energy options, and we must work to make sure they are fully capitalized. When the money is there, the jobs in energy will be there. The energy then will be there to support jobs throughout the economy, and we will be vulnerable no longer to the threats and bluster of either foreign suppliers or our own national energy and financial conglomerates.

Solar Energy Employment*

Girard W. Levy, Battelle Columbus Laboratories, Columbus, Ohio

INTRODUCTION

Interest in solar energy applications has a history of peaks and valleys in the United States. Recently, of course, interest has accelerated to the point where the national effort in solar energy research and development probably exceeds one billion dollars a year. It is expected to reach several billion dollars soon when solar devices are more widely marketed.

The growing emphasis on solar energy applications implies future demands for a variety of manpower skills and capabilities, including research and development skills, analysis and design skills, manufacturing skills, and installation and maintenance skills. Many of these skills and capabilities may be available in adequate numbers through normal reallocation of manpower resulting from private sector market forces (e.g., job openings, differential wage rates, and investment decisions). On the other hand, adequate availability of some skills may require considerable advanced planning and public sector support, particularly where rapid development and implementation of new technologies is expected. Information about needed skills and capabilities, provided through manpower surveys and forecasting, aids in the formulation of government policy and can be used in making policy decisions regarding R&D contracts, educational support, manpower training, and other programs. Manpower surveys and forecasting are especially important when anticipated manpower shortages or surpluses could act as a constraint on Federal policies or programs.

With regard to solar energy manpower, the concern is that a lack of adequately trained manpower could constrain the development and acceptance of solar energy as an alternative energy source. First, the development and application of solar energy may create additional employment opportunities that exceed the available manpower pool. This could be particularly true if there are new Federal initiatives in solar R&D or new incentives for commercialization. Second, the existing employment opportunities may require new skills or a different mix of skills than is currently possessed by the workforce. For example, additional training in solar applications for engineers and technicians may be required.

---

* This study was jointly sponsored by the Office of Education, Business, and Labor Affairs and the Office of Solar Applications, U.S. Department of Energy under Contract Number EG-77-01-6037. The views or conclusions contained herein are the responsibility of the author alone, and do not necessarily represent official opinions or policies of the sponsoring organization.

Objectives and Scope

The purpose of this study was to describe the characteristics of establishments engaged in solar energy work, and the number and occupation of persons working in solar energy activities. The study, conducted in 1978, also projected future solar manpower requirements through 1983. Prior to the study, sound data on the solar energy industry and on solar employment were not available. The study, therefore, was exploratory in nature and broad in scope.

The scope of the study included all types of solar energy technologies and applications (space heating and cooling, water heating, industrial process heat, thermal power, ocean thermal conversion, photovoltaic conversion, wind conversion and biomass conversion), and all phases of solar work (research and development, manufacturing, marketing and distribution, and installation and maintenance).

Results

The data for the study were collected by a mail survey of employers engaged in solar energy activities. Questionnaires were sent to over 2800 establishments. Over 50 percent of those contacted responded. Detailed information was provided by 563 employers engaged in solar energy work. These employers reported the type of organization, industrial classification of their establishment, principal solar products and services, types of solar energy technologies involved, total employment and solar employment, occupations of those working in solar, number of additional solar jobs anticipated, new solar job specialities, sources of solar funding, and anticipated future commercial solar sales.

The survey responses, undeliverable mail and follow-up telephone calls indicated that there is frequent entry and exit of firms in this infant industry. It is estimated that approximately 2000 establishments (both public and private) were engaged in solar energy activities in 1978. Approximately three out of every four of these establishments were primarily working in solar space and water heating. Most establishments, however, were involved in many different types of solar energy and in many different phases of solar work. Over 60 percent of the respondent establishments categorized themselves as private industry or business. The states with the most solar establishments were California (16 percent of the total), New York (8 percent), Massachusetts (7 percent), Colorado (4 percent), and Texas (4 percent).

Approximately 30 percent of the respondent establishments were involved in the manufacture of solar collectors or other solar products. About 23 percent provided research and development services, and 18 percent provided architectural and engineering services. Twelve percent of the respondent establishments were engaged in installation and 16 percent provided other solar-related services.

The establishments engaged in solar work tended to be small in size. Table 1 presents the data on establishment size and percent of employees engaged in solar work. Thirty-seven percent of the establishments had 10 or fewer employees. Only 20 percent had over 400 employees. These larger establishments, however, employed 40 percent of all persons working in solar. The percentage of employees engaged in solar work varied inversely with the size of the establishment. That is, establishments with 20 or fewer employees had over 80 percent of their employees engaged in solar work. In contrast, establishments with more than 400 employees had about 1 percent of their employees engaged in solar work.

TABLE 1: Mean Percent Solar Employment By Establishment Size

Total Employment (Solar and Nonsolar)	Percent of Respondent Establishments	Mean Percent Solar Employment
1– 10	37	83
11– 20	13	83
21– 40	10	25
41–100	11	22
101–400	9	8
Over 400	20	1

Establishment size was also related to the type of solar work performed. Installation, architectural and engineering services, and miscellaneous services were performed mainly by small organizations, whereas R&D work was performed mainly by large organizations. Manufacturing work was performed by both large and small establishments. Approximately 75 percent of the solar work of large establishments was in R&D.

The total estimated number of persons working in solar in 1978 was 22,500. This figure represents all employees, full and part-time, direct and support, working in solar. Table 2 presents the estimated employment in solar activities by occupation. A number of important characteristics of solar energy manpower can be seen in this table. Engineers comprised the largest occupational group among persons engaged in R&D activities. Unskilled workers made up the largest occupational group in commercial activities, and skilled workers made up the largest occupational group in installation. Engineers also comprised the largest occupational group overall. The number of persons working in solar R&D was slightly greater than the number working in solar commercial and installation activities combined. Not shown in the table is the fact that 65 percent of all solar employment was in establishments primarily engaged in solar space and water heating.

TABLE 2: Estimated Employment In Solar Activities By Occupation

Occupation	R&D	Commercial	Installation	Total
Engineers	5,100	1,600	200	6,900
Scientists	1,700	200	—	1,900
Other Professionals	1,800	1,300	100	3,200
Technicians	1,800	600	100	2,500
Skilled Crafts and Operatives	900	2,400	600	3,900
Clerical and Unskilled	1,200	2,600	300	4,100
Total	12,500	8,700	1,300	22,500

The number of hours worked in solar and nonsolar activities are important indicators of manpower utilization. About half of the persons working in the field were working part-time in solar-related work during the survey period. The average number of hours spent in solar-related work activities was approximately 30 hours per week. The percentage of time spent on solar-related work was higher for manufacturing employees and lower for employees engaged in installation and maintenance activities. Only one-third of those working in installation and maintenance worked full-time in solar. Thus, the solar manpower pool was under utilized.

Table 3 presents the estimated solar employment and the gain in solar employment anticipated by employers in different geographical regions. Again, the data are for all employees, full

TABLE 3: Estimated Solar Employment and Number of Additional Jobs By Geographic Region

Region	Estimated Solar Employment	Estimated Number of Additional Jobs	Anticipated Percentage Change (1978–1981)
I	2,900	3,100	105.0
II	2,500	2,000	78.2
III	3,700	2,900	77.8
IV	2,100	1,500	73.7
V	3,100	1,700	54.8
VI	900	1,000	111.7
VII	400	500	120.0
VIII	1,500	1,400	95.9
IX	4,900	5,100	103.2
X	400	200	45.0
Total	22,500	19,400	86.2

and part-time, direct and support. The largest gains were anticipated in Regions I and IX. The overall anticipated gain in solar employment by 1981 was 86 percent. Additional analyses disclosed that the largest gains were anticipated for skilled workers and technicians in the fields of manufacturing and construction.

Employers were also asked to indicate which solar occupations were difficult to hire. The most-difficult-to-hire solar occupations reported included engineers, atmospheric scientists, systems researchers, and college instructors. The least-difficult-to-hire solar occupations were clerical, skilled and unskilled workers.

One of the objectives of the study was to identify new job specialities in the solar area. Only one out of every four employers thought their professional, technical or skilled craft employees performed tasks that were substantially different from those traditionally performed in nonsolar jobs. Where new skills were identified, special solar design, analysis and installation skills were most frequently mentioned by employers. Thus, there appears to be some need for persons trained in the design and analysis of new solar systems, and for persons trained in installing these systems. However, these employees must be capable of performing work in areas other than solar. For example, they must be able to design or install conventional as well as solar hot water systems.

A majority of the technical employees working in solar energy had not completed any formal training programs or courses in solar energy. This was true of persons working in R&D as well as persons working in installation and maintenance. When formal training had occurred, nearly 60 percent of the formal solar energy courses taken were provided by colleges and universities. The average duration was between 20 and 40 hours.

Most technical employees (over 60 percent) felt that they needed more education and training for their work in solar. The areas where additional education and training were needed (such as analysis and design of systems, mechanical engineering, and management) were not unique to solar, but rather represented traditional subject matter areas being applied to solar energy problems.

Employment Projections

An objective of the study was to develop and apply a methodology for projecting future employment in solar energy. Two separate projection methods were developed; one for forecasting R&D solar employment, and one for forecasting commercial solar employment. Both methods were used to project employment for three years (to 1981) and five years (to 1983).

The projections of R&D solar employment were based on projected Federal funding of solar R&D, and on the proportions of solar R&D expenditures which were Federally financed (as reported by establishments). Each type of solar energy was treated separately. In deriving the projections, it was assumed that R&D employee productivity will remain constant through 1983, and that R&D productivity is not related to establishment size. Further assumptions were made with regard to the rate of decline in Federal involvement in R&D financing for each type of solar energy.

The projections of commercial solar employment were based on labor coefficients, defined in terms of labor-hours per unit of installed solar equipment. Only solar space heating and cooling, water heating, and industrial process heat were assumed to produce significant commercial employment by 1983. The employer survey did not provide information necessary to compute the commercial labor coefficients because companies considered sales data to be proprietary information. Estimates of the labor coefficients for production and installation of solar units were obtained from a small sample of companies. The available estimates of labor coefficients, as well as the estimates obtained and used in this study, were highly variable from company to company. The changing proportions of different types of collectors and concentrators which will be used, and productivity changes were estimated to 1983. Projections of commercial solar equipment sales were obtained from published sources. These sales forecasts were applied to the estimated labor coefficients to obtain the projections of commercial solar employment.

Table 4 presents the projected changes in solar employment for R&D and commercial activities. Solar employment in R&D activities is projected to increase from 1978 levels by 74 percent by 1981 and by 144 percent by 1983. Commercial solar employment (for those technologies which are currently commercialized) is projected to increase from 1978 levels by 137 percent by 1981 and by 203 percent by 1983. Overall, full-time equivalent employment is projected to double by 1981 and nearly triple by 1983, based on projections of recent trends in Federal R&D funding and commercial solar sales. The projections cannot anticipate technological breakthroughs in production and installation techniques, improvements in system cost-effectiveness, changes in incentives to purchase solar units, or major shifts in Federal funding of solar R&D. The projections, based as they are on many assumptions and limited data, should be regarded with caution.

TABLE 4: Projected Changes in Solar Employment

	Percentage Change	
Activity	**1978–1981**	**1978–1983**
R&D	74	144
Commercial	137	203
Weighted Total	102	170

Training for Solar Jobs: A Follow-up of California CETA* Programs and Their Graduates

Barbara A. Burns, Bert Mason and Gail Y. Mikasa,
Solar Energy Research Institute, Golden, Colorado

INTRODUCTION

Several recent studies have indicated that commercialization of solar energy will create expanded job opportunities requiring skills different from those in the conventional energy industry (Rodberg 1979; U.S. Congress 1978). Although there is significant disagreement among researchers about the net job creation potential of solar energy, it is probably safe to say that if the President's stated goal of 20% of total U.S. energy needs being met by solar in the year 2000 is achieved, the solar industry will provide substantial employment opportunities. In fact, if this goal is to be attained, a well-trained work force to manufacture, design, and install solar technologies will be necessary.

A key concern in developing solar training efforts to meet this expanding demand is whether jobs in the solar industry can be targeted towards the unemployed or underemployed. The major premises which support the assertion that solar energy will ultimately offer employment possibilities to CETA-eligible individuals are: (1) a substantially new job market will be created that cannot be met by existing labor market participants; and (2) individuals who do not have appropriate skills to compete in the current job market can be readily trained to manufacture, install, and maintain solar systems.

This study was undertaken as an initial effort to provide needed information on this issue by identifying the types of solar training being offered by CETA-funded programs and the labor market experiences of graduates from these programs. In order to reduce the effect of differences in climate, state incentives for solar energy, and a number of other factors, the initial research was conducted on programs within one state.

California was chosen as the site for the initial project for a number of reasons. The state is currently involved in a large variety of solar-related activities, including developing jobs and job training programs in solar energy. California contains a relatively large number (12) of CETA solar training programs, which provides a range of designs and characteristics. There have been more than 500 graduates from these programs (by December 1979), a sufficient sample for collecting data on the labor market experiences of persons trained for solar jobs.

---

*Comprehensive Employment and Training Act

This project is part of a larger employment and training research effort being conducted by SERI which includes the review and development of data on solar energy labor requirements, survey and data base of training and education programs, and regional and national solar energy employment projections.

RESEARCH APPROACH

Objectives

The project has three major objectives:

1. To develop and test procedures which could be used to assess a generic type of solar training effort (CETA-sponsored programs) which has been included in the DOE/DOL/CSA SUEDE program, and is being funded by state CETA offices and prime sponsors;
2. To provide in-depth descriptions of the California CETA solar training programs for persons planning or managing solar training programs, including issues such as union response and institutional arrangements for providing the training; and
3. To describe and analyze the employment experiences of the graduates of the California CETA solar training programs.

Technical Approach

The technical approach involved: (1) a reviewing of the literature on evaluation of manpower and training programs, (2) designing and monitoring an empirical study of the California CETA solar training programs and their graduates, and (3) analyzing the field data.

Information on the twelve CETA programs was collected by the SERI project staff in June and July of 1979, using an interview guide. This interview guide was reviewed by the programs in a preliminary visit. In June, SERI staff met with personnel from the CETA solar training programs to obtain background information on each program. The interview guide was used to collect this information. From this information, program descriptions were drafted and returned to the programs for comment and modification.

To collect information on the labor market experiences of the CETA program graduates, SERI staff constructed a participant questionnaire. Under contract with SERI, the State of California's SolarCal Office identified and located program participants through program records. Between June and September of 1979, personal interviews with program participants were conducted by SolarCal staff. The number of interviews and approximate number of total participants by June 1979, for each program are shown in Table 1. Of approximately 450 participants 151 interviews were conducted.* The range of interviews per program as a percentage of total program graduates is 16-100%. Differences in sampling are the result of pragmatic factors such as ease of locating graduates and geographic distance from Sacramento, rather than a purposeful emphasis on particular programs.

Responses on participant questionnaires were computer-coded by SERI staff, and analyzed using the Statistical Package for Social Sciences (SPSS). Frequency distributions and summary statistics for the major variables were calculated for each program and for the total sample, and standard statistical analysis (cross tabulations, correlations) was conducted to identify major causal relationships (e.g., factors affecting post-program wage rates).

The program and graduate interviews were aimed at answering three main research questions:*

1. How many and which of the graduates of CETA solar training programs are working in solar energy-related jobs?
   a. What types of solar jobs are they filling?
   b. What factors have restricted their ability to find solar jobs?
   c. What, if any, interaction with unions have they had?
2. Are there particular components of the training programs that are related to the placement of graduates in solar jobs?
3. Have those graduates working in solar jobs found their CETA training adequate for the job-required skills?

---

*A detailed list of the types of information collected from program managers and participants is attached as an appendix.

---

* Seven of the interviews could not be used because of missing answers, or because the student had either not been in the solar program or was currently in the program. The remaining 144 interviews were used for the analysis. Of these 144 participants, 126 (88%) completed the CETA training program. The remaining 18 (12%) dropped out before graduation.

DESCRIPTION OF THE CETA PROGRAMS

The use of California CETA funds to provide solar training began in 1976. At the time the field work for this study was conducted (May-August 1979) twelve programs were (or had been) operating and graduated about 450 individuals. Students from these programs were trained for a variety of jobs in the solar industry—manufacturing, installation, maintenance, design, and sizing.

The programs vary widely in their design. Some grew out of earlier weatherization programs, while other programs are the first and only offering of a training organization. Some programs offer up to a year of college credit; other programs offer only OJT experiences. Some programs include specialized staff and well-equipped workshops; others use unpaid volunteers and minimum shop equipment.

TABLE 1. Graduates and Interviews by Program

Program	No. of Graduates[a]	No. of Interviews	Interviews as % of Graduates	% of Total Interviews
1. Net Energy	4	3	75.0	2.1
2. Proteus	20	13	65.0	9.0
3. Lakeview	70	11	15.7	7.6
4. Westside CDC	250	61	24.4	42.4
5. Sky Ray	45	16	35.5	11.1
6. Santa Clara Adv. Trng. Center	1	1	100.0	0.7
7. Sonoma	44	30	68.2	20.8
8. Sacramento/Yolo	20	9	45.0	6.3
Total	454	144	31.7	

[a] Approximate number of total program graduates, June 1979.

The California CETA solar training programs are spread throughout the state. Specific characteristics of the programs vary, since in all cases they were designed to meet the needs of the local environment and the program participants. Summaries of the programs are provided in Table 2, which reviews the history and current status of the programs, and Table 3, which reviews the characteristics of the training. Detailed, narrative descriptions of the programs are found in the final report on the project (Burns, Mason, and Mikasa 1980).

CHARACTERISTICS AND EXPERIENCES OF PROGRAM PARTICIPANTS

Demographic and Educational Characteristics

Slightly more than two-thirds of the students interviewed were male (102 males; 42 females). About half of the interviewees were white (75), with those remaining split among black

TABLE 2. Summary of California CETA Solar Training Programs

Name and Location of Program[a]	Funding Source	Sponsoring Organization	Date Program Started	Length of Training Program	Number of Graduates as of 12/1/79	Current Status
The Firebox Solar Water Heating Program Pic-Tower House Weitchpec Route Hoopa Post Office Hoopa, CA 95546	CETA and BIA	Klamath River Citizen Council	December, 1978	18 months	8	Active
Solar Technician Training Net Energy Program 630 Ninth Street Arcata, CA 95521	CETA DOL/DOE (HUEDE)	Humbolt County	March, 1979	9 months	14	Terminated December 1979
Solar Demonstration Project Lakeview Educational Association 833 W. Fir Street San Diego, CA	CETA	San Diego Regional Employment Training Consortium	January, 1979	15 weeks	41	Terminated September 1979
Solar/Energy Technician Training Program Sonoma State University 1801 E. Cotati Rohnert Park, CA 94928	1st year Gov. discretionary 2nd yr. CETA	Sonoma County	September, 1978	9 months	47	Terminated September 1979
Solar Training Program Proteus Adult Training P.O. Box 727 Visalia, CA 93279	Gov. discretionary CSA CETA (Title III)	Self	February, 1978	5 months	28	Active

[a] This list does not include the Sacramento-Yolo Pilot Program or the Santa Clara OJT Program.

TABLE 2. Summary of California CETA Solar Training Programs(concluded)

Name and Location of Program[a]	Funding Source	Sponsoring Organization	Date Program Started	Length of Training Program	Number of Graduates as of 12/1/79	Current Status
Solar Energy Technician Training Program Manpower Services City of Richmond 330 25th Street Richmond, CA 94804	competitive demonstration grant (STIP)	City of Richmond	June, 1979	18 months 6 months OJT	0	Active
Solar Technician Training Program Sky Key 290 Gale Way Hayward, CA	CETA	Alameda County Training Employment Branch	August, 1978	15 weeks	45	active
Solar Energy Project Economic Opportunity Commission Tap Roots Home 1186 Garden Street E. Palo Alto, CA 94303	CETA NCAT	County of San Mateo	January, 1979	6 months	5[b]	Active
Solar Training and Utilization Community Resource Project 2317 S Street Sacramento, CA 95816	CETA	Sacramento Employment and Training Agency (City and County)	April, 1979	6 months and 3 months OJT	9	Active
San Bernardino West Side Community Development Corporation 1736 W. Highland Ave. San Bernardino, CA 92411	Multi (15 sources)	Inland Manpower Association	1976	6 months 6 months OJT	300	Active

[a] This list does not include the Sacramento-Yolo Pilot Program or the Santa Clara OJT Program.

[b] As of July 1979.

(43), Hispanic (18) and other minority groups (Oriental and Native American) (8).

The ages of the graduates ranged from 18 to 53, most of the students were in the younger age groups. In Table 4 demographic information for those interviewed is summarized. Three-quarters of the students (110) were single, and about two-thirds (99) had no dependents other than themselves. Only 9 of the 144 had four or more dependents. About two-thirds of the students had been raised in urban or suburban areas (47 and 45 students, respectively). Forty-one had been raised in small towns and only 10 in rural areas.

The graduates were generally well educated. Only 14 of the 144 had not completed high school.* Seventy-seven had college experience, 19 had received degrees. (This figure includes junior or community colleges as well as four-year colleges and universities.) Of those with college degrees, 19 received bachelor's degree while 2 had earned a master's degree. The total distribution of formal education is shown in Table 5.

About half of the students had received training from former employers or the military. Sources of prior training are shown in Table 6. Only thirty-two (22%) of the participants interviewed had received previous training in one or more CETA or similar programs.

Employment Backgrounds

Participants in the CETA solar training programs came from a variety of occupational backgrounds. Three job categories—structural work; service; and professional, technical, and managerial—account for more than half of the total responses. Perhaps most important is the fact that most of the participants held several different types of jobs. Of the 128 respondents, 76 (59%) listed at least three previous occupations. The prior jobs held by the graduates are shown in Table 7. The relatively high proportion of professional, technical and managerial occupations (16.5%) is somewhat surprising for a sample of CETA-eligible individuals. Twenty-eight percent of the participants held jobs that would involve construction-type skills (machine trades, benchwork, and structural work).

The mean number of employers since age 18 for the sample is approximately 7. Since the average age of participants is slightly less than 25 years, this means that the average participant has had about one employer per year since age 18. These data indicate that the participants in the solar training programs exhibit employment histories that are probably typical of CETA-eligibles—frequent job changes with relatively short tenure in each job. This generalization is supported by the variety of types of jobs participants held since age 18; almost 50% of the participants responded that they had performed "several" or "many" different kinds of work.

---

*Some of these participants received their diploma or GED as part of the CETA program.

Experience with the Solar Training Program

Participants learned about the solar programs from a variety of sources. Forty-five of the graduates found out about the program through relatives or friends, 22 through media sources (television, newspapers, posted bulletins), and 5 by word of mouth. Informal and formal CETA information channels were often used. Eighteen of the students were referred by other CETA programs, while 52 became informed through people involved in the program or through the program itself.

The reasons for signing up for the program were varied. Sixty-two of the students applied because of an interest in solar energy; 63 were more concerned with getting a job, developing more marketable skills, or entering trades. Thirty-four students expressed general curiosity or thought it looked like a good opportunity.*

The majority of the graduates were satisfied or very satisfied with the programs (see Table 8). They did, however, point out a number of problems which they suggested should be solved for future cycles of the course. These suggestions ranged from changes in the course content and equipment to interpersonal treatment of the graduates. The suggestions most often made were that the bureaucratic problems and amount of red tape be reduced (14 graduates); more hands-on experience (17) and more on-the-job or field experience (11); a longer training period (11); and better job placement (10).

Somewhat less frequently mentioned were a need for more in-depth or specific training (8), more individual attention (8), and better organization or administration (8).

Graduate Placements

In order to obtain information on the types of jobs that graduates from the CETA programs have obtained, several questions were asked the participants about their post-program labor market experiences.

The types of jobs—in terms of occupational category—found

---

* Multiple answers were allowed.

TABLE 3: Characteristics of Training

Program	Length	Hours/Week	Classroom	Hands-on	On-the-Job Training	Number and Types of Systems Installed During the Program
[illegible]	18 months	20	none	18 months 20 hrs/week		35 installations: wood stove water heating systems and solar water heating systems on native American homes.
[illegible] Energy	9 months	30	3 months	3 months of workshops included with class sessions and 6 months actual installations		15-18 domestic hot water systems, including 10 bread box heaters; 2 or more self-built flat plate heaters and 4 commercially available systems; 4-6 space heating systems, including air heaters and direct gain (thermal mass); 4-6 solar greenhouses.
[illegible] Educational Association	15 weeks	26	7 weeks	Actual installations during 1st 7 weeks and 8 week OJT	40 hrs a week students are paid the normal wage rate. LEA reimburses the employer half of the wage rate as compensation for training the students.	1 flat plate domestic hot water heater, 1 bread-box water heater, 2 greenhouses at the community level, and 1 jacuzzi.

TABLE 3 (cont.)

Program	Length	Hours/Week	Classroom	Hands-on	On-the-Job Training	Number and Types of System Installed During the Program
Sonoma	9 months	38	11 hrs/week	Actual installations on. Alternative Energy Center building and individual projects 8 hours/week.[1]		Constructed 800 sq. ft. Alternative energy center demonstration active and passive solar system: 2 domestic hot water systems (one active and one bread box); 3 space heating systems which included one air system and 2 water systems and a direct gain space heating system. Also construced non-attached greenhouse, and numerous student projects.
Proteus	6 months	35	10/hrs/week	Workshops and actual installations	Optional 2 months OJT. Proteus compensates the company 50% of trainees salary.	28 active domestic hot water systems, 37 bread boxes, solar heating system for swimming pool, a hot water system for use in the dairy at the local community college, and a greenhouse.
City of Richmond	18 months	38	12 months	In class workshop and OJT	6 months w/ local private employees. Company is compensated by the program.	Solar heating system for swimming pool at Community College. Will solarize a light house off the coast of the Port of Richmond.

by participants after leaving the CETA programs are presented in Table 9. Professional, technical and managerial, (33 of 123) and structural work (51 of 123) occupations total about two thirds of the first jobs found when the individuals left the programs. Virtually all of the jobs in the professional, technical, and managerial category and 69% of these in structural work involved solar energy.

Eight percent of the participants (12 of 144) were unable to find jobs initially. At the time of the interviews, 23 of the 126 who had graduated were unemployed. Of the 18 who left the program before completion, 7 were unemployed.

For first jobs after leaving the program, the average starting wage was $4.33/hr. Wages at the end of the first job (either current wage at the time of the interview or wage when the participant left the job) averaged $5.20/hr. There is also some indication that individuals who left their initial jobs were able to find better-paying jobs (at least for the second, third, and fourth jobs). For example, starting salaries for second jobs averaged $1.27/hr higher than those in the initial jobs ($5.60 vs. $4.33/hr), and the starting salaries for second jobs were higher than the average top wage in first jobs ($5.60 vs. $5.20). In terms of hourly wage rates, it therefore appears that graduates of CETA solar training programs have been able to advance, both by working at the same job and by finding new ones. It is also important to note that 103 of the 114 participants responding to the wage question were able to find employment paying more than the current federal minimum wage rate ($2.90/hr) at the time of the interview.

TABLE 4: Demographic Information About Program Participants Interviewed

		Age						
Ethnic Background	Sex	18–19	20–24	25–29	30–34	35–39	40 or Older	Total
White	Male	1	21	19	6	3	2	52
	Female		6	12	4		1	23
Black	Male	6	22	1				29
	Female	1	12				1	14
Hispanic	Male		10	2	3			15
	Female		3					3
Other, Oriental	Male		2	2	1	1		6
(Native American	Female		1	1				2
Totals		8	77	37	14	4	4	144

TABLE 3: (concluded)

Program	Length	Hours/Week	Classroom	Hands-on	On-the-Job Training	Number and Types of System Installed During the Program
Sky Ray	15 weeks	30	6 weeks	9 weeks Workshops and actual installations	Work w/private companies on weekends	7 domestic hot water systems (open and closed loop active systems and glazed panels) and active systems (glazed and unglazed panels) for swimming pools.
Economic Opportunity Commission	6 months	40	15 hrs/week 8 hours of support classes and 2 hours on solar energy	25 hrs/week actual installation and OJT	Work 10-12 hours/week, including weekends w/ private companies primarily installing hot tubs and swimming pool applications	Built a solar house, which includes a domestic hot water system and a greenhouse.
Community Resource Project	9 months	40	6 months	Workshops and skills development work experience retrofit low income housing.	3 months	Built and installed 4 domestic hot water systems, 2 greenhouses, and 1 active flat plate system.
West Side CDC	16 months	40	33% of total hours	33% of total hours in Laboratory work and 33% in actual installations		Manufacture won solar systems contracted installations and retrofits with public housing projects: 100 bread boxes and flat plate collectors, 10 fan coil space heating systems, one greenhouse.

[a] The Sacramento-Yolo pilot program was no longer in operation only OJT experience. at the time of this study. The Santa Clara program involved

TABLE 5: Distribution of Participants' Formal Education

Formal Education Levels	No. of Graduates
Eighth grade	1
Some high school	13
High school graduate	51
Post-high school, noncollege	2
Some college	58
College degree	19
Total	144

TABLE 6: Employment Training prior to the CETA Programs

Courses provided by employer	4
On-the-job training	21
Trade or vocational-technical school	10
School	2
Military	15
Junior or community college	1
Apprenticeship	4
Other	16
None	67

To provide some insight into the steadiness of employment found by graduates, participants were asked how many hours of work per week they averaged in their first job. Most of the participants were able to find full-time work; 82 responded that they were working 40 hours per week. Only 16 said they were working 30 or fewer hours per week.

The length of employment in jobs was also determined. For first jobs, the average length of employment was 6.5 months; 61 individuals were still at their first job at the time of the interview. Second jobs averaged 7 months, and 26 (54% of those who took second jobs) were still employed in this job.

A significant percentage of those interviewed left their initial jobs, and some have held four or more jobs. To determine reasons for these job changes, participants were asked why they left their previous jobs. The most frequent reasons given were that they found better jobs, the business or project was discontinued, or there were particular aspects of the job they did not like.

TABLE 7: Types of Jobs Previously Held

	Job Category[a]	Number	%
1.	Professional, technical, & managerial	63	16.5
2.	Clerical	25	6.5
3.	Sales	20	5.2
4.	Service occupations	63	16.5
5.	Agricultural,fishing, forestry	29	7.6
6.	Processing	11	2.9
7.	Machine trades	20	5.2
8.	Benchwork	9	2.4
9.	Structural work	79	20.7
10.	Miscellaneous	39	10.2
11.	Unskilled (unspecified)	17	4.5
12.	CETA or similar programs	3	0.8
13.	Student	1	0.3
14.	Occupations in solar (unspecified)	3	0.8
	Total	382[b]	

[a] Job categories are defined in Appendix D.

[b] Total responses (382) exceed number of interviews (144) due to multiple answers. Responses are summarized as follows: No response: 16; one previous job: 21; two previous jobs: 31; three previous jobs: 32; four previous jobs: 23; five previous jobs: 10; and six previous jobs: 11.

Participants were asked two specific questions that attempted to relate their experiences in the labor market with the solar training program. The first was, "Did the training program help in finding your first (post-program) job?" Of the 125 who answered this question, 86 (68.8%) responded "yes," while 39 (31.2%) responded "no."

The second question was, "Do you feel that the training program adequately prepared you for the work you are doing?" The majority of the participants (57.1%) felt that the programs provided adequate training, while about 23% believed the training was inadequate for the jobs they found.

One issue related to solar jobs is the role of union and nonunion labor. Trade unions are anxious to ensure solar employment for their members, while nonunion individuals view the solar industry as an opportunity to open fields of employment to people such as CETA-eligibles. As a result, trade unions have been less than enthusiastic about CETA-funded solar training efforts, except perhaps as pre-apprenticeship programs.

To provide some information on the experience of graduates of CETA solar training programs with trade unions, participants were asked about their contacts with unions. Of the 110 respondents, only 11 (10%) stated that they had worked with union members on a job site. Graduates were also asked, "Are you now in any way affiliated with a union?" Of the 143 responses, 21 (15.9%) indicated they were affiliated with a union.

Solar Employment and Experience

Seventy-one of the respondents indicated that the first job they obtained after leaving the program involved solar energy. As indicated in Table 9, most of the solar jobs were in the professional, technical and managerial fields (32) and the structural work category (35). For those who left their initial jobs, the relative proportion of those who found solar jobs declined slightly. At the time of the interviews, 62 had solar-related jobs. Additionally, many of the respondents were very recent graduates from the solar training programs, and much of the career "sorting out" that will occur has not yet been observed. About 80% of those whose first job had a solar component spent more than three quarters of their time on solar work.

Of the 144 participants interviewed, 66 (46.5%) indicated that they had worked on solar installations since leaving the program. Most of the graduates (39) who had installed solar systems had worked on 10 or fewer installations. Eighteen graduates had worked on 11-100 installations. Seven individuals reported that they had worked on more than 100 systems.

In terms of types of solar systems installed by graduates, nearly all were some form of residential hot water system. Domestic hot water systems and pool and hot tub applications accounted for 86% of the solar installations. Although almost all of the interviewees (64 of the 66 who had installed solar systems) indicated that they worked primarily on single-family home installations, a significant number (45) had also installed solar systems on multifamily residences and commercial buildings.

TABLE 8: Participants' Satisfaction with Program[a]

	Very Dissatisfied	Dissatisfied	Can't decide, did not have, or no answer	Satisfied	Very Satisfied
Feedback from trainers about performance	.7%	6.3%	9.7%	59.%	24.3%
Work assignments for workshop sessions	4.2	14.6	9.7	56.3	15.3
Time with instructors	2.8	12.5	4.7	62.5	17.4
Handling of job placements	9.0	16.0	13.2	36.1	25.7
Tools provided	1.4	8.3	6.3	59.7	24.3
Manuals provided	.7	7.6	19.4	50.0	22.2
Way tools and manuals were provided	.7	4.2	5.6	74.3	15.3
Program administration in general	9.0	16.0	13.9	40.3	20.8

[a] In cases where two responses were marked they were averaged and then rounded toward the center point.

TABLE 9: Type of Job after Program, Solar vs. Nonsolar

(First Job)

Job Category	Yes		No	
	Number	% of Total "Yes"	Number	% of Total "No"
Professional, technical, managerial	32	45.1	1	1.9
Clerical	3	4.2	3	5.8
Sales	1	1.4	1	1.9
Service occupations	0	0	9	17.3
Agricultural, fishing, forestry, & related occupations	0	0	4	7.7
Processing	0	0	3	5.8
Machine trades	0	0	5	9.6
Benchwork	0	0	4	7.7
Structural work	35	49.3	16	30.8
Miscellaneous (unspecified)	0	0	4	7.7
Unskilled	0	0	2	3.8
Total[b]	71	100.0	52	100.0

[a] Occupational categories from the Dictionary of Occupational Titles. Fourth Edition. U.S. Depatment of Labor, Employment and Training Administration; 1977.

[b] These totals exclude 5 students; 12 unemployed; one person in job Categoy 1 who did not respond; two in Categoy 7 who did not respond, and one in Category 8 who did not respond.

Factors Affecting Placement Experience

In order to identify factors that may influence post-program job experiences of the participants, an analysis was conducted of relationships between participant characteristics (e.g., demographics, prior education) and placement data (e.g., type of job, wage rate). Results should be interpreted as indicators of general relationships rather than as statements of causality and magnitude.

The ethnic group, sex, and previous education of the participant appeared to influence the type of job found upon leaving the CETA solar training program. Most (over 90%) of those who obtained jobs in the professional, technical, and managerial category had some college (35%) of a college degree (59%). In structural work, where 35% of the participants found jobs, the educational background apparently had little or no effect; 21 had a high school diploma and 27 had a college background. Women were disproportionately represented in the professional, technical, managerial job category (40% of all females interviewed). In the structural work category, however, there was a comparatively low percentage of women (14% of the females interviewed). This seems to reinforce the expressed concerns of some of the program directors and participants that female students were having trouble breaking into traditionally male construction trades. The women, however, were less likely than the men to be unemployed. Only one of the 12 participants who said that they were unemployed immediately after the program was a woman. The relationship to ethnic background showed most clearly in the professional, technical, managerial job category, which was dominated by whites (76%). Only 7% of the Blacks and 12.5% of the Hispanics were in that category. However, the relative proportion of whites and of those in the "other" category was about the same (35% and 37.5%). The structural work category and the unemployed category showed a somewhat more even distribution by race.

Previous education and ethnic group appeared to be related to whether the first job involved solar. Sex did not appear to be a factor. Of those with college experience or degrees (68 students), 73% were placed in solar jobs. There was an equal percentage of men and women (58%) who listed their first job as involving solar energy. Of all white respondents, 78.5% said their first job involved solar; for non-white respondents, only 33% were employed in solar jobs.

Wage rates did not significantly vary with respect to sex. There did appear to be some ethnic group differences, however. Only 1 white (1.8% of whites) listed his/her top wage rate for the first job as less than $3.01/hr, while 11 nonwhites (22.4 of non whites) were in this category. The respondents listing their top wage rate above $5.00/hr included 44% of all white respondents (25 of 57) and 35% of all nonwhite respondents (17 of 49).

For both initial and top wage rates, more participants who had jobs involving solar were in the higher wage rate categories than those whose jobs did not involve solar. For their initial wage rate, 31% of those in solar jobs were earning over $5.00/hr, compared with 8% of those in nonsolar jobs. For their top wage rate, 80% of the respondents in solar jobs were earning over $5.00/hr, compared with 30% of those in nonsolar jobs.

Findings from Program Experiences

The program and participant interviews and a project review meeting in Sacramento resulted in a number of general findings or "lessons" from the program experiences. These are briefly outlined here; a more detailed discussion is presented in the final project report.

The findings can be grouped into four categories: (1) program components and characteristics, (2) curriculum design and implementation, (3) student selection and characteristics, and (4) placement experiences.

Program Components and Characteristics

- Availability of funding for the programs and for solar installations is the major problem facing the programs. Delays in obtaining promised funding have caused changes in the proposed efforts; some sponsors perceive the solar programs as too expensive; and financial support for the actual installations has been hard to obtain. CETA funds cannot be used for permanent installations. Other funding sources have included HUD, CSA, BIA, and the building owners.
- Conservation and weatherization efforts should be combined with the solar training activities. This serves the dual function of adequately preparing installation sites for solar systems and of providing the students with a broader range of job skills and employment opportunities.
- An increase in solar training programs may further increase the shortage of qualified instructors. Because of the range of qualifications required and the present shortage of individuals meeting the requirements and willing to teach in solar CETA programs, many programs have already turned to consultants, visiting instructors, and faculty from local community colleges.
- A sufficient number of staff is required to handle both teaching responsibilities and the administrative paperwork for the CETA grant. An appropriate staff/student ratio should be determined and applied to program planning.
- It is critical that local employment opportunities be assessed carefully. One way in which the California programs are able to gain this information is by appointing and using an advisory board comprising members of the local solar industry. The advisory boards provide feedback to the programs on the types of training needed by local industry and facilitate placement of graduates.

- The unions' role in CETA solar training programs needs to be defined. At this stage, it appears that trade union participation in the California CETA solar programs has been limited to individual union members sitting on advisory boards and providing some part-time teaching assistance.
- Student job placement is perhaps the primary concern of the program, in part because this is a major factor used by prime sponsors in evaluating the programs. Some programs have felt pressured by prime sponsors for both a high placement rate and a high proportion of placements in solar jobs. Because of the current availability of solar jobs, program directors felt that "successful" placement of graduates should include employment in a variety of fields related to the training, including general construction, and not just solar.

Curriculum Design and Implementation

- The scope and depth of instruction that can be covered in the CETA programs depends in large part on their length and number of training hours per week. Some of the programs have chosen to limit their instruction to one or more of the basic trades skills, such as plumbing, with minor coverage of solar specific skills. Others focus on specific solar skills and information, assuming that their trainees will be assisting journeymen on specific installations.
- While practical experience is important, program directors cautioned that it should not preclude classroom work. Some programs integrated OJT experience with the classroom sessions, while others completed classroom work before beginning field installations or OJT.
- All of the programs include a training mix of general skills, solar-specific skills, and basic job behavior and skills. Program directors felt that such a mix was necessary because of the job opportunities available to their graduates, the skill requirements for solar installations, and the lack of specific or related job skills and experiences of many of the participants.
- While program directors recognized the benefits of comparability and control across training programs, they also felt strongly that the program must be tailored to the local job market and to the particular program participant. One compromise between consistency and flexibility is a set of standardized curriculum modules that can be used in a variety of course combinations.

Student Selection and Characteristics

- A controversy exists about the use of aptitude tests rather than interview judgments in the student selection process. Some programs, because of their curriculum content, screened for 9th-grade math ability; other programs gave aptitude tests to the students after they had been accepted, using the results for guidance and training.
- Both program directors and prime sponsors are concerned that the early cycles of the CETA solar programs may be "skimming" the best of the CETA eligibles. The perceptions of some intake agencies of the solar programs as the top choice for training combined with pressures for high placement rates encourage selection of more highly qualified and motivated applicants. Yet, this may limit the programs' ability to serve a large portion of the CETA-eligible population.
- Program directors differ as to whether all students should have the same skills or should be at different levels. The main arguments for homogeneity are: ease of planning and carrying out training; and more similar, evenly-paced assignments during workshop sessions and OJT assignments. Arguments for a mix of skill levels in the courses are that a mixture does not "skim" the upper levels of CETA-eligibles; is more similar to real-world job experiences; and encourages the students to help each other.
- The program directors felt that student expectations for solar employment are, in many cases, a problem for the programs and for the students. Particular expectations included: that the level of pay in solar jobs will be high; that the solar jobs will be more glamorous or exciting than traditional jobs; and that participants can be virtually assured of getting a solar job. Four of the programs meet with the students before or just after the selection process, in order to discuss what to expect in solar jobs.

Participant Experiences

- Ninety-two percent of the participants interviewed found immediate employment upon leaving the program. At the time of the interviews, 78% of the participants were still employed.
- The participants' jobs were generally full-time and fairly high-wage jobs. Only 16% of the students reported that they were working 30 or fewer hours per week.

- Initial and final wages for first jobs averaged $4.33/hr and $5.20/hr, respectively. For those who moved into other jobs, the comparative averages in the third job were $6.34/hr and $6.64/hr.
- Four categories—professional, technical, and managerial; structural; service; and machine trades—accounted for more than 70% of the first jobs.
- Seventy-one of the graduates indicated that their first jobs involved solar energy. Eighty percent of those with solar-related jobs spent more than three-fourths of their time on solar activities. At the time of the interviews, 62 of those interviewed were in solar jobs.
- Solar jobs appeared to pay more than nonsolar jobs. At the time of the interviews, 84% of those with solar jobs were earning more than $5.00/hr, while only 56% of those in nonsolar jobs were earning more than $5.00/hr.
- Overall, the graduates were generally satisfied with the training they received in the solar programs. The majority of them felt that their training adequately prepared them for their current work.

REFERENCES

Rodberg, L. S., 1979. *Employment Impact of the Solar Transition*. Prepared for the Subcommittee on Energy, Joint Economic Committee, Congress of the United States. U.S. Government Printing Office; April 6.

Congress of the United States, 1978. *Creating Jobs Through Energy Policy*. Hearings before the Subcommittee on Energy, Joint Economic Committee, 1978. U.S. Government Printing Office; March 15–16.

Burns, B. A.; Mason, B.; Mikasa, G. Y., 1980. *Assessment of the Labor Market Experiences of CETA-Trained Solar Workers*. SERI/RR-53-396. Golden, CO: Solar Energy Research Institute. (In press).

APPENDIX

1. Program Characteristics
   a. What are the objectives of the training program?
   b. What changes or modifications have occurred in the program and why?
   c. What types of persons are participating in the program and how are they selected?
   d. What are the characteristics of persons who do not complete the program?
   e. What is the content of the program (e.g., how much time is devoted to hands-on experience and in what setting)?
   f. What types of placement assistance are offered to the graduates?

g. What are the local conditions that influence the job market for the program graduates?
h. What types of instructors are used by the program?
i. What are the programs' relations with other organizations (industry, union, and training)?
j. What general types of problems have the programs encountered, and how have they responded?

2. Graduate Characteristics and Labor Market Experiences

a. What are the demographic characteristics of graduates from the California CETA solar training program?
b. How did they get into the training program, and why?
c. What were their employment skills and experiences prior to the solar training program?
d. Have the graduates found jobs in the solar energy industry? If yes, what types of jobs are they filling and do they see their training as adequate; if no, what factors do they see as restricting their job opportunities?
e. What types of solar systems have the graduates worked on since leaving the program?
f. How satisfied are the graduates with the amount and type of training they received?
g. What kinds of interaction with unions have the graduates had?

Occupational and Training Requirements for Expanded Coal Production

John B. Ostbo, The Conference Board, Washington, D.C.

BACKGROUND

At the dawn of the 1980's, it is a widely shared outlook that coal is likely to be an increasingly attractive energy alternative. As shown in Table 1, concurrent with a doubling of the U.S. energy market by the year 2020, coal is expected to increase its share of total energy supply from 20 percent to nearly one half. Despite dramatic growth of nuclear energy, coal will dominate well into the next century.

TABLE 1. Long Term Energy Supply for the United States

	1977	2000	2020
Total Supply (Quadrillion Btu)	79.8	125.0	169.1
Distribution (percent)	100	100	100
Coal	20	38	46
Nuclear	3	14	26
Oil (Domestic)	25	20	12
Oil (Imported, net)	23	9	4
Gas (Domestic)	25	15	7
Other	4	4	5

Source: U.S. Department of Energy, Energy Information Administration, *Annual Report to Congress 1978,* Vol. 3, DOE/EIA-0173/3, Table 5.2.

The bright future for coal is the result of numerous assumptions concerning the demand for energy, as well as the prices and availability of alternative sources of energy. In the case of coal, which is relatively labor intensive, it is generally assumed that there will be an adequate supply of coal miners and managers trained to produce coal in an efficient and safe manner. Several factors, however, provide grounds for concern as to the validity of this assumption:

- The dramatic projected expansion of coal production. Total annual coal production may reach 2.0 billion tons in 1995, and nearly 5.0 billion by the year 2030, roughly six times present levels.

- The sharp decline of coal mining productivity during the 1970's. Production per person per shift declined from 19.9 tons in 1969 to 14.8 tons in 1977. If this trend continues, roughly one million additional coal miners will be required to sustain the production of 2.0 billion tons in 1995, for example.
- The massive outbreak of wildcat strikes since the late 1960's, particularly in the Eastern coal fields. In 1976, a year not affected by a national UMWA strike, nearly 2.0 million person shifts were idle due to such work stoppages, corresponding to roughly 30.0 million tons of coal and more than $100 million in lost earnings.
- The record long 110-day UMWA contract strike of 1977-78.
- The pervasive factional strife within the UMWA under the leadership of Mr. Arnold Miller. Since work stoppages and discontent represent losses to both labor and management, improved handling of grievances and contract negotiations is obviously high on the list of goals currently pursued by the coal industry. The President's Commission on Coal announced recently a training program, developed jointly by representatives of NCA, BCOA, and UMWA, designed to help coal companies achieve this goal.
- The high rates of labor turnover and absenteeism.
- The sharp increase of average, unit labor costs, which more than doubled during the period 1967-77.
- The emergence of "boomtown" problems in some of the rapidly growing Western mining communities.

Beginning in early 1978, sponsored by the Electric Power Research Institute (EPRI) and the U.S. Department of Energy (DOE), THE CONFERENCE BOARD has been engaged in research designed to assess the extent to which the labor outlook may constrain the prospective expansion of the coal industry. The EPRI report, scheduled for publication in June 1980, presents labor force projections for coal mining areas and provides a comprehensive discussion of the adequacy of labor supply. The EPRI report also presents an assessment of the coal industry labor relations outlook as well as detailed projections of coal production, coal mining productivity, labor requirements, and labor costs, by type of mining and coal producing regions. Finally, the EPRI report presents "illustrative" projections of long term labor requirements and potential labor supply to the year 2030.

The ongoing DOE project is designed to supplement the work completed for EPRI, particularly concerning occupational and training requirements for expanded coal production. Important components of this work include a mail survey of coal industry training programs and detailed occupational breakdowns of coal mining employment. The focus of this paper is on our DOE project.

The Training Survey

The survey conducted by The Conference Board is designed to determine the extent to which coal mine operators currently provide training for their employees in excess of minimum Federal and State requirements. The emphasis is therefore on skill training for maintenance personnel, equipment operators, first line supervisors, and managers. All coal companies or affiliated company groups which produced at least 300,000 tons of coal in 1977 were invited to participate in the survey, roughly 350 companies. The mailing list was developed using the computerized data bank maintained by the McGraw-Hill Keystone Coal Industry Manual, supplemented by personalized addresses for the 50 largest companies.

Three survey instruments were developed, each providing different types of information:

- A *company* level questionnaire.
- A *mine* level questionnaire.
- An abridged *follow-up* questionnaire.

In addition to the *company* level questionnaire, the participating companies were asked to complete and return the *mine* level questionnaire for a random sample of roughly 300 mines, stratified by type of mines and number of mines operated. The mine sample was drawn from separate listings of the coal mines operated by the 350 companies invited to participate in the survey, provided annual production exceeded 100,000 tons in deep mines and 200,000 tons in surface mines. These minimum tonnage sizes were selected, based on recent productivity statistics, to limit the survey of individual mines to those which employed at least 50 miners. All of the 50 largest coal mines were included in the sample.

At the present stage of our survey, we have received approximately 50 completed *company* questionnaires, 50 *mine* questionnaires, and 40 *follow-up* questionnaires. As expected, the responses are biased toward larger companies, most likely to have internal training programs. The companies which have responded account for more than 50 percent of coal industry employment. Only three of the 15 largest coal companies did not respond.

The specific issues addressed in the survey include the following:

- In what year was a separate training unit or function first established?

  Our preliminary results show that the emergence of coal industry training programs is a recent development. Only four companies reported having an administratively separate training unit established by the late 1960's. Sophisticated skill training programs may of course also exist in companies where the training function is administratively merged with a broader human resources development program, emphasizing personnel administration and industrial relations. In the majority of companies, the health and safety director is apparently also responsible for training, suggesting that internal training programs are limited to mandated training for newly hired miners, annual refresher training, task training, and certification training.

  This late awakening to the need for formal training is not surprising. Following World War II, the coal industry experienced a major contraction of production and employment. From a peak of 631 million tons in 1947, coal production declined to 400 million tons during the early 1960's. During this period, major energy using sectors, particularly railroads, industrial users, and retail consumers, converted to fuels such as oil and natural gas which were cleaner and generally less costly to produce, store, and transport. Concurrent with the declining demand for coal, the so-called productivity policy of the UMWA during the John L. Lewis era—which encouraged technological progress—also tended to reduce the demand for labor. The combined impact of these factors was to eliminate roughly 300,000 coal mining jobs. Consequently, when coal production resumed a moderate uptrend during the 1960's, largely as a result of sharp growth of electric power consumption, an ample reserve of experienced coal miners was available.

- What types of training are offered?

  The level of detail is indicated in Figure 1.

  Our preliminary results indicate that many responding companies provide formal training programs for maintenance personnel and first line supervisors, while on-the-job training appears to be the most common approach for equipment operators. Formal training is also provided in a large number of companies for middle and top level managers, professionals, and technicians, such as dust analysts and environmental technicians. The length of training varies greatly, from less than 8 hours to more than two years for some of the combined classroom and on-the-job training programs, while 40-80 hours is quite typical.

- What types of training facilities are used?

  An above-ground facility at the mine location, such as a mobile training unit, or other company facility away from the mine site are checked by a majority of the respondents. A section of a mine is typically used for miners' skill training. Local educational institutions and simulated mines are apparently used less frequently. However, it should be noted that coal companies which are too small to sustain internal training programs for particular occupations probably draw on community resources to a greater extent than the medium and large companies responding to our survey. This issue will be explored during our field visits.

- What types of instructors are used?

  Health and safety training, as well as supervisory training, are typically provided by company employed full-time instructors, while part-time services of supervisors are frequently used to provide miners' skill training.

- What types of training materials are used?

  The training programs appear to be largely based on material developed internally, but supplemented by material made available by government agencies, equipment manufacturers, trade associations, and consultants.

- How satisfied are the coal companies with the training programs available to their employees?

  Many companies noted a great need for improving the business management skills of management and professional level employees. Not surprisingly, a number of companies reported that they planned to introduce or increase training in labor relations and human resource management skills. A majority appear to be satisfied with their mandatory health and safety programs, but not with the training available to their first line supervisors. As for training programs provided by, or partially sponsored by, various external institutions, university and community college programs appear to be well received. In general, coal companies are also satisfied with the programs offered by the Mine Safety and Health Administration (MSHA) and the Federal Mediation and Conciliation Service (FMCS).

	Number of Employees Receiving Training (past 12 months)	Currently Offer, Plan to Expand Program(s)	Not Now Offered, Plan to Offer
Basic Health and Safety Training			
☐ **Health and safety training to orient *new inexperienced* miners**	______	☐	☐
☐ **Health and safety training to orient new miners who have previous experience**	______	☐	☐
☐ **Health and safety refresher training offered annually to experienced miners**	______	☐	☐
Mining Skills Training for Maintenance Mechanics/Electricians			
Initial skills training:			
☐ **On-the-job training only**	______	☐	☐
☐ **Classroom training, combined with o.j.t.**	______	☐	☐
☐ **Courses to upgrade the skills of maintenance mechanics and electricians**	______	☐	☐
☐ **Training specifically for certification tests**	______	☐	☐
Skills Training for Equipment Operators/Other Hourly Workers			
Initial skills training:			
☐ **On-the-job training only**	______	☐	☐
☐ **Classroom training, combined with o.j.t.**	______	☐	☐
☐ **Courses to upgrade the skills of equipment operators and other hourly workers**	______	☐	☐
☐ **Training specifically for certification tests**	______	☐	☐
☐ ***Any Other Skills Training for Miners (describe)***	______	☐	☐
Foreman Training			
☐ **General supervisory training**	______	☐	☐
☐ **Specialized courses in supervisory skills**	______	☐	☐
☐ **Training for specific foremen certification tests**	______	☐	☐
☐ ***Management training* (for levels above chief foremen and for professional staff)**	______	☐	☐
☐ ***Technician training* (e.g., dust analyst, environmental technician)**	______	☐	☐

Figure 1

Occupational Requirements

An important component of our current work for DOE is to provide occupational data for coal mining based on the 1978 Occupational Employment Statistics (OES) survey. We are working closely with the Bureau of Labor Statistics (BLS) to develop a special coding procedure which will permit us to generate detailed occupational breakdowns specified as follows:

- Total coal mining.
- Deep coal mines.
  —Deep mines using long-wall machines.
  —Deep mines using continuous mining machines.
  —Deep mines using conventional mining machines.
- Surface coal mines.
- Coal preparation plants.
- Coal mining administrative offices.
- Coal mining services.
- Coal producing regions (EAST, CENTRAL, WEST).

This information will be useful not only in describing the present occupational structure of coal mining employment, but also to provide improved projections of future occupational requirements.

Training Requirements

Another important task in connection with our current work for DOE is to assess future coal industry training requirements. Conceptually, this involves quantifying the need for training:

- To fill new coal industry jobs generated by expansion of production or declining labor productivity (GROWTH).
- To replace workers separating permanently from the coal industry due to retirement, death, or disability (ATTRITION).
- To replace workers leaving coal industry jobs to work in another industry, enter the military or schools, become unemployed, or classified as not a member of the labor force (INTER-INDUSTRY SEPARATIONS).
- To replace workers who terminate employment with one coal mine operator to work for another (INTRA-INDUSTRY MOBILITY).
- To replace workers who change jobs, but remain employed by the same coal mine operator (INTRA-EMPLOYER JOB SHIFTS).
- To upgrade the skills of workers who remain employed in the same job by the same coal mine operator (UPGRADE).

Although conceptually simple, the scarcity of good data concerning replacements needs makes this a difficult task. The UPGRADE component is also particularly difficult to quantify since there is no consensus in the coal industry as to what constitutes optimal training to perform particular coal mining jobs in a safe and efficient manner, let alone information which adequately describes the current coal mining work force. To attempt to bridge this data gap, we are examining data from several sources:

there is no concensus in the coal industry as to what constitutes optimal training to perform particular coal mining jobs in a safe and efficient manner, let alone information which adequately describes the current coal mining workforce. To attempt to bridge this data gap, we are examining data from several sources:

- Our ongoing training survey which will enable us to estimate separation rates for broad categories of workers in the responding companies: hourly wage employees, clerical, foremen, and management.
- Separation and accession rates estimated based on the Continuous Work History file of Social Security records (10 percent sample), derived in connection with our EPRI project.
- Estimates concerning most of the training objectives listed above developed by JOHN SHORT & ASSOCIATES in connection with a recent study for the U.S. Bureau of Mines, based on the Continuous Work History file of Social Security records (1 percent sample) and new data generated through a survey of individual mines.

SUMMARY

The final report to DOE is scheduled for completion in July 1980. Our objective is to provide a quantitative basis for assessing the current status of training for the major coal industry occupations, and for projecting future training needs.

A major data gap, which has not been addressed by our study or by other on-going research, relates to the qualitative adequacy of coal industry training programs, using such criteria as their impact on accident rates and productivity. Additional research is needed to assess the effectiveness of alternative training strategies, based on these key performance measures.

Preliminary Forecast of Likely U.S. Energy Consumption/ Production Balances for 1985 and 2000 by States[1]

J. F. Gustaferro, Office of Ocean, Resource, and Scientific Policy Coordination, U.S. Department of Commerce, Washington, D.C.

INTRODUCTION

These projections are based on an earlier Department of Commerce national-level energy forecast, Forecast of Likely U.S. Energy Supply/Demand Balances for 1985 and 2000 and Implications for U.S. Energy Policy,[2] and were prepared in support of an interagency effort under the direction of the Department of Interior, to assess the adequacy of the U.S. water resource base to meet future energy development and production needs. A key feature of the report is that energy production and consumption estimated for the years in question (1976, 1985 and 2000) are tabulated for each State in a common format so that easy comparisons can be made. Data provided include: population, energy consumption (for all energy sources), energy facilities, future energy produced (oil, natural gas and coal), output from electrical power sources (oil, gas, coal, nuclear, hydro/geo., other), water requirements, energy facilities (LNG terminals, coal gasification plants, petroleum refining capacity and electric power plants by fuel source), data on number of solar installations, windmills and energy output from agricultural and municipal waste, tons of high level nuclear residue, and the number of gasohol plants.

At the first International Conference on Energy Use Management,[3] I had the opportunity to present the U.S. Department of Commerce's Forecast of Likely U.S. Energy Supply/Demand Balance for 1985 and 2000 and Implications for U.S. Energy Policy. Almost immediately after this presentation the Department of Interior requested that this forecast be used to determine the water requirements for the production of this energy by Water Resource Regions. In order to satisfy this request it *was necessary to disaggregate the Commerce Forecast into the* respective states and then to apportion state energy facilities into the Water Resource Regions.

The intermediate step produced a useful compilation of data and is the forecast presented in our "State" energy forecast which is the subject of this paper.

National Forecast

In our national forecast we used a combined engineering/energy usage approach. We balanced the postulated energy requirements for each of about 35 uses and the availability of supply at an economical price. At each decision point a considerable amount of judgment was injected. Our own judgment was tempered and compared with results of other studies based on price elasticity, on supply availability, and on statistical extrapolation. In reality the model is largely judgmental at the macro level.

The basic assumptions of the national forecast were reported to you last year and can be summed up in a single statement. They are reasonable assumptions derived by extrapolating the past fifty years of national utilization of energy bounded by finite world and national petroleum and natural gas resources.

The projections presented in the State forecast, of course, are conditioned by the same assumptions and judgments that apply to the earlier national-level forecast on which they are based and, hence, must be considered tentative and preliminary until reviewed and evaluated by appropriate State energy planning agencies.

Additional assumptions were:

- In order for an energy facility to produce or convert energy, it must occupy a specific site. In other words, everything must be some place.
- All natural resources, e.g., coal, can only be obtained from States that have that natural resource.
- Disaggregated energy values, no matter how surprising they look, must add up to the aggregated value. The sum of the energy parts must equal the whole.
- Energy production (domestic production plus imports) must equal consumption a State cannot consume energy that it does not have or cannot acquire from external sources.

In order to disaggregate the National forecast into the State forecast, we started with the per capita energy consumption by states by user sector. We then modified this per capita usage again by user sector (industrial, residential, transportation) at the same rate as per changes of our national forecast. This value was then multiplied by the anticipated increase of population for each State. Finally, minor changes were made to compensate for anticipated sociological changes in a few States. The sums of State energy were then adjusted to coincide with forecast national energy totals.

Figures 1 through 17 summarize in bar chart form some of the contrasting features of the U.S. energy picture at the State level in 1985 and 2000. Among the features worth noting are:

- Overall U.S. population is expected to increase to 262,000,000, or some 22 percent, by the end of the century. This approximates the Census Bureau Series II projection. Certain states will grow very little in population terms (e.g., the Northeastern States), however, while others (California, Florida and the Sun Belt States) will grow rather dramatically. This has implications for future energy consumption and production patterns in the United States.
- Oil consumption will continue to increase through 1985 but decrease sharply through the rest of the century. Similarly, oil production except in the case of Alaska and some non-major oil producing States, will continue to decline steadily through the rest of the century.
- Gas consumption is expected to decline gradually though steadily (except in the case of Texas) through the rest of the century. Gas production also will decline in the continental United States, though much more sharply. The gap between supply and demand in this case is expected to be filled by gas from Alaska, imports from Mexico and Canada, Liquefied Natural Gas (LNG) imports and coal gasification.
- Coal consumption, on the other hand, is expected to increase steadily through 1985 and rise sharply thereafter through the rest of the century. To meet this demand, coal production in the producing States will rise accordingly (more than double in most instances), with the greatest percentage rise taking place in the western producing States.
- Electrical power consumption is expected to increase steadily for all States for the rest of the century (more than doubling in many cases) and will require the completion of 544 additional plants of a nominal megawatt capacity (one every 16 days through the year 2000). (A nominal plant assumes an average of 1,100 megawatt capacity.) Because of expected limitations on the availability of traditional

power generation sources, a considerable number of these plants will have to be nuclear powered. The number of nuclear plants required to satisfy California's electricity needs is projected to increase from one nominal plant in 1976 to 32 in the year 2000. The number of such plants in New York is projected to increase from 4 to 22.

- As one might expect, the amount of water that will be consumed in energy development and production will increase markedly in those States where new energy production (including electrical power generation) takes place.

There are no conclusions or findings presented in the forecast as such. In addition to offering an approach and a basis for improved coordination and interaction between Federal, Regional and State agencies in the energy field, however, it is hoped that those who go through it carefully will better understand many of the fundamental issues still to be resolved in dealing with the national energy problem. For example:

- Can the United States and the individual States build the number of nuclear and coal burning electrical utility plants forecast in the face of the environmental, safety and resource problems that exist? For example:
- Will we build 264 nuclear plants by year 2000 if this means 3 in Rhode Island, 11 in North Carolina, 22 in New York and 32 in California?
- Will we provide the transportation required to mine 800 million tons (23 million BTU standard tons) of Western coal? (800 million tons equal 1,150 million tons of the average ton of Western coal containing 16 million BTUs.)
- Will the Eastern States dramatically increase their coal production by the year 2000. For example, West Virginia from 111 to 292 million tons, Kentucky from 147 to 342 million tons, and Pennsylvania from 86 to 203 million tons?
- If we do not build the nuclear plants and/or mine these large amounts of coal, will we face massive electric power shortages during the 1990's?
- Can renewable or the so-called inexhaustible energy sources (solar, waste materials, geothermal and those generally classified in the "other" category) make a significant contribution to the energy supply during the critical transition period when they will be most needed (1985-2000)?
- Will it be feasible for the United States to purchase from abroad sufficient energy to compensate for the shortfalls expected?
- If not, can levels of employment, GNP and the U.S. standard of living be maintained with far less energy than has

been the case in the past? If so, with how much less?

These are questions and issues that must be faced and dealt with at the State and regional as well as the national level.

I happen to believe that we as a nation *will* face up to these questions and face up to them boldly—once the issues are understood and our energy needs made clear. Perhaps, when all is said and done, this is the major contribution forecasts can make—to help us understand those issues and needs. Although I have tried to stress today that forecasts must rely extensively on judgment and that there is no sure formula which gives us the future, particularly if that future is determined to any large degree by human behavior or action in the preceding period, they are an essential component of or precondition for effective long-range energy planning.

Such planning, I would note, is not just the province of Government agencies or multi-national corporations. It should be undertaken by all major energy users, including industrial sector (or sub-sector) users such as yourselves.

I have not focused on the implications for such planning that derive from the two Department of Commerce forecasts I have discussed today. I would rather have you read these forecasts (and others that are available), study them and draw those implications for yourselves. Apart from what I think you will have already concluded from what has gone before, namely that by the end of the century we will still be heavily reliant on the same energy sources we depend on now (oil, gas, coal and electricity from nuclear, hydro and coal) and that energy costs will be extremely high, I will make only one last point—that is that none of us are likely to get to the year 2000 from here unless we develop an entirely new commitment to energy conservation. We must keep our per capita energy growth rates within the manageable 1.0 to 1.2% we have projected in our forecast and if we are to achieve the kind of economic growth we all want, this means more effective and efficient use of the energy we have available.

On January 28, 1980 the Department of Commerce released the third volume in this series. The new resource study projects requirements for capital, labor, material and equipment, natural resources, and operating and maintenance expenditures to achieve the energy consumption and production foreseen in the forecast. According to the study, the resource consequences of the Department's year 2000 forecast would include the following:

- Between 1977 and 2000, the cumulative capital requirements for energy projects would aggregate $1,620 billion (in 1978 dollars);
- By 1997, the annual use of aluminum in developing new energy facilities would be 688,000 tons, compared to 96,000 tons per year in 1977;
- Carbon steel requirements for energy facilities would rise from 6.6 million tons per year in 1977 to 8.6 million tons annually by 1997;
- Engineers needed for energy facility design, construction, and start-up would rise from just over 33,000 in 1977 to almost 59,000 by 1998;
- Electricians engaged in the development of new energy facilities over the same period would rise from about 18,500 to more than 57,000;
- Energy-related water use would grow from 8.2 million acre-feet per year in 1977 to over 18.6 million acre-feet per year in the year 2000.

The new Commerce report is entitled "Projected Annual Resource Requirements at the National and Regional Level for the Department of Commerce Energy Forecast 1985 and 2000." Limited copies are available from the Office of Ocean, Resource, and Scientific Policy Coordination, U.S. Department of Commerce, Room 5717, Washington, D.C. 20230, or by telephone (202) 377-4363.

When this supply is exhausted copies will be available from: National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, Telephone (202) 724-3382, Order No. PB-80-126956.

REFERENCES

1. Office of Ocean, Resource and Scientific Policy Coordination, U.S. Department of Commerce, Preliminary Forecast of Likely U.S. Energy Consumption/Production Balances for 1985 and 2000 by States, Washington, D.C. (NTIS. PB-287-486 November 1978).
2. Domestic and International Business Administration, U.S. Department of Commerce, Forecast of Likely U.S. Energy Supply/Demand Balances for 1985 and 2000 and Implications for U.S. Energy Policy (prepared by Office of Energy Programs), Washington, D.C., January 1977. (NTIS. PB-266-240, $8).
3. Energy Use Management, Proceedings of the International Conference, Vol. II, p.587

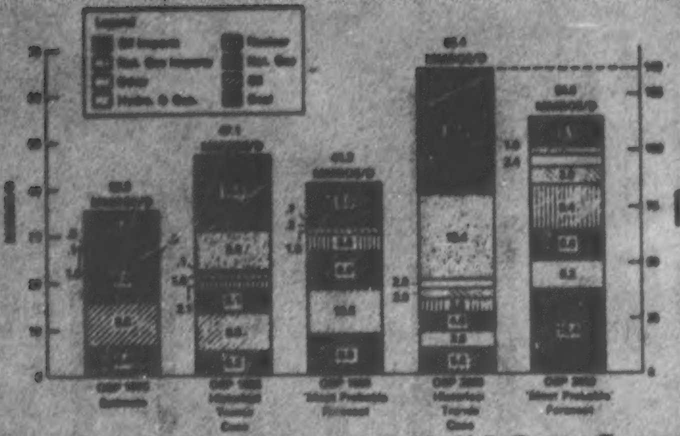

Figure 1: Historical and Most Probable U.S. Energy Forecasts for 1985 and Year 2000

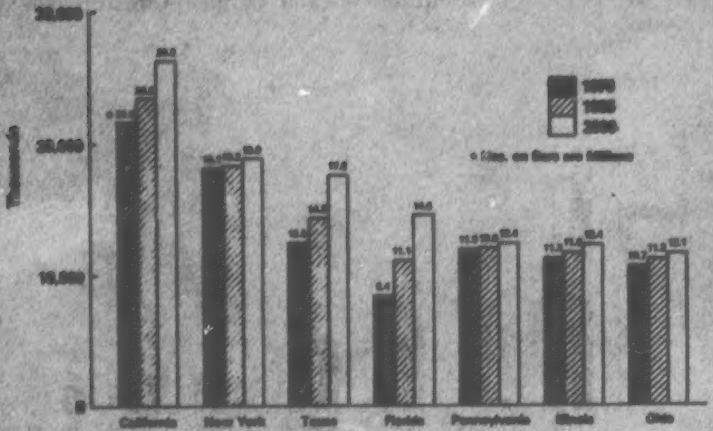

Figure 2: Population—Seven Highest—Yr 2000

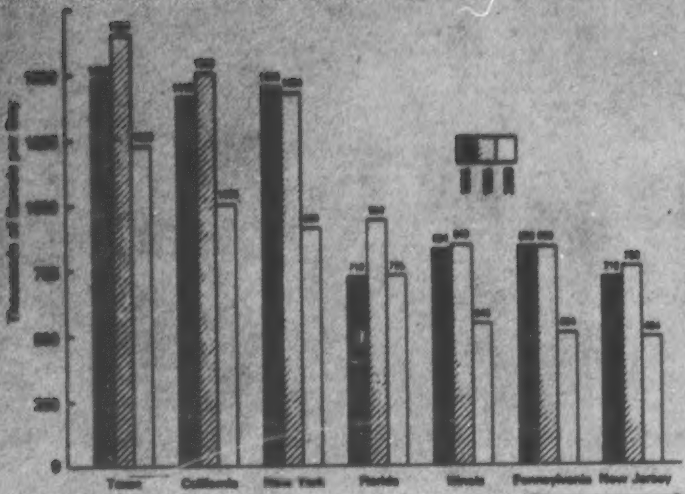

Figure 3: Oil Consumption—Seven Largest Consumers—Yr 2000

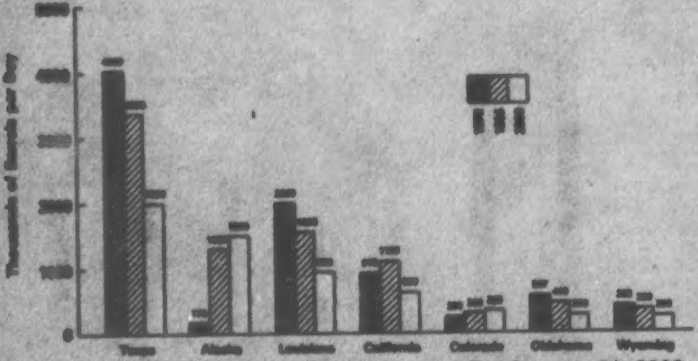

Figure 4: Oil Production—Seven Largest Producers—Yr 2000

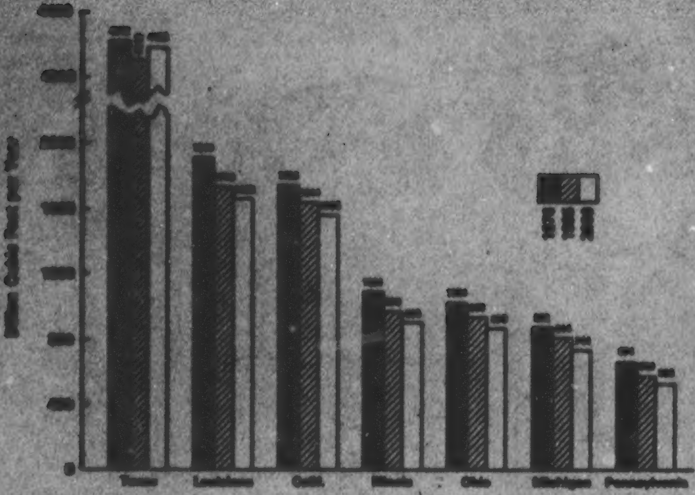

Figure 5: Natural Gas Consumption—Seven Large User States

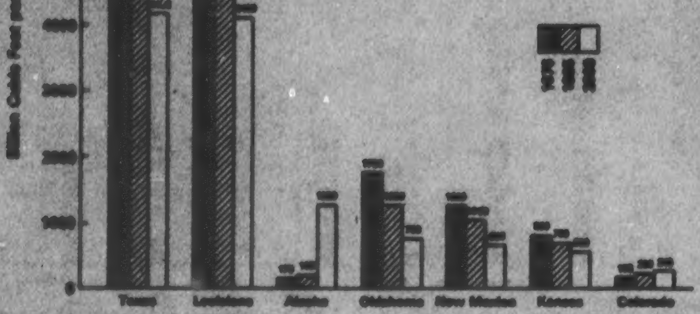

Figure 6: Natural Gas Production—Seven Largest Producing States—Yr 2000

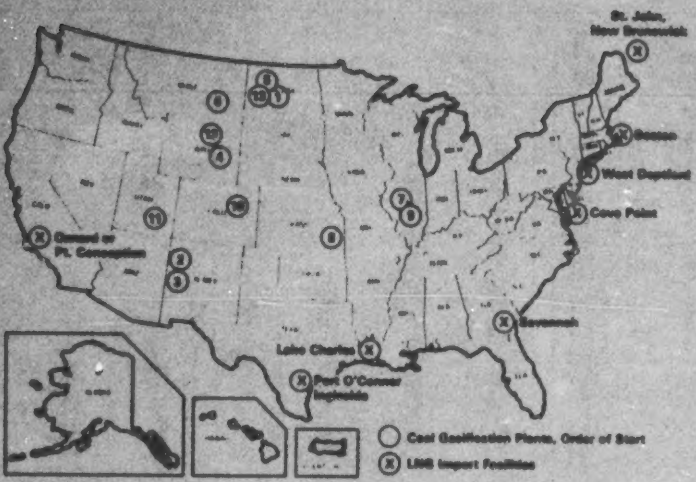
St. John,
New Brunswick
Boston
West Deptford
Cove Point
Savannah
Lake Charles
Port O'Connor
Ingleside
Coastal or
Pt. Conception
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Coal Gasification Plants, Order of Start
LNG Import Facilities

Figure 7: Coal Gasification and LNG Facilities—Operational Facilities by Year 2000

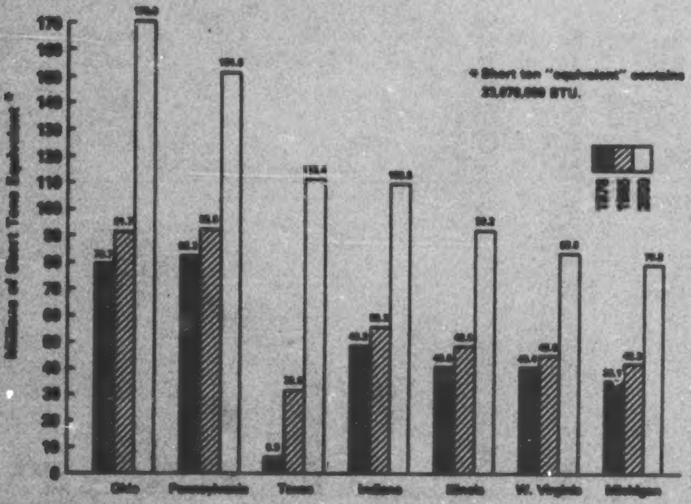

Figure 8: Coal Consumption—7 Illustrative States (Largest Users–Yr 2000)

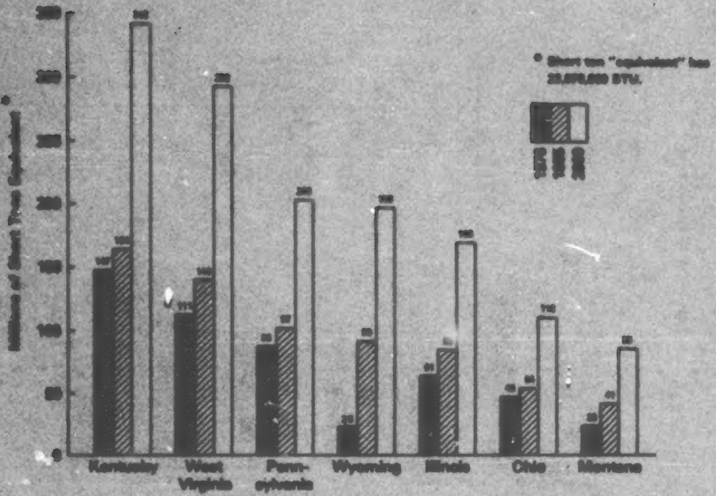

Figure 9: Coal Production—Seven Largest Producing States Year 2000

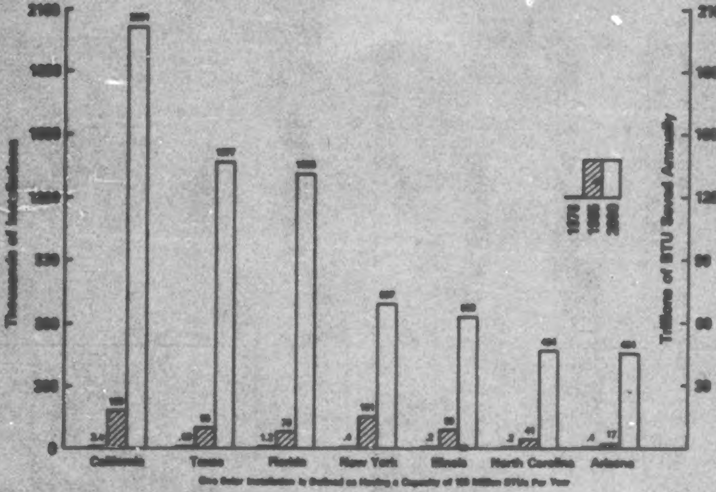

Figure 10: Solar Installations—Seven Highest States, Year 2000

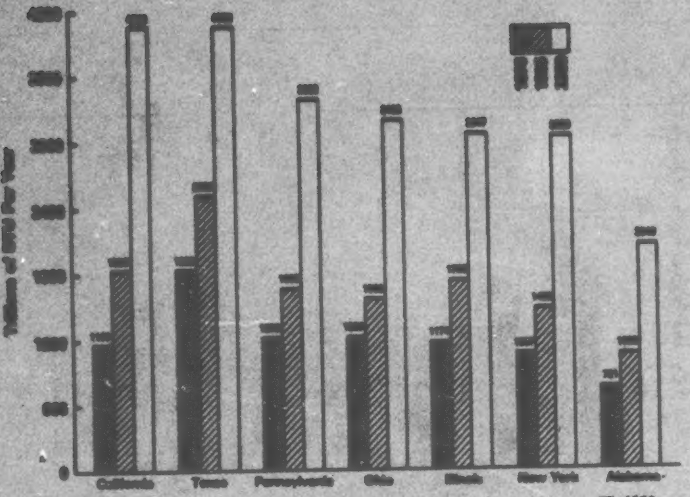

Figure 11: Electrical Power Plant Fuel Consumption—Trillions of BTU Per Year—One KWH Requires 10,400 BTU

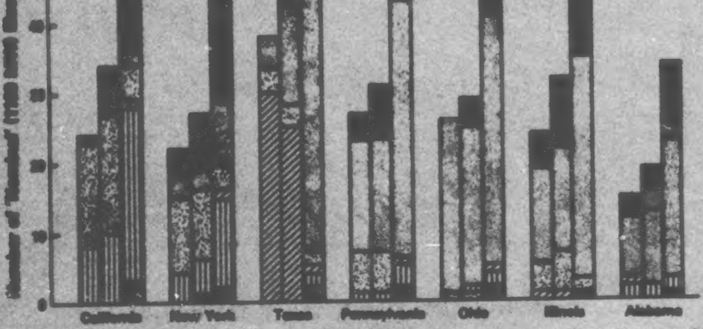

Figure 12: Approximate No. of Electric Plants of 'Nominal' Size Required in 7 Illustrative States

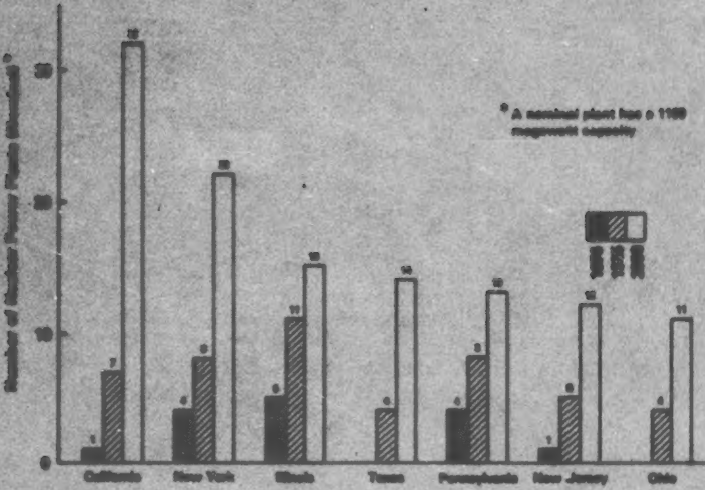

Figure 13: Nuclear Power Plants—Seven Highest States, Year 2000

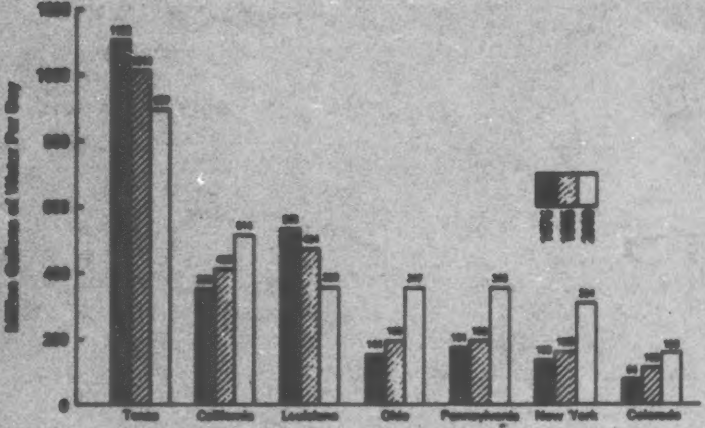

Figure 14: Water Consumed in Energy Production

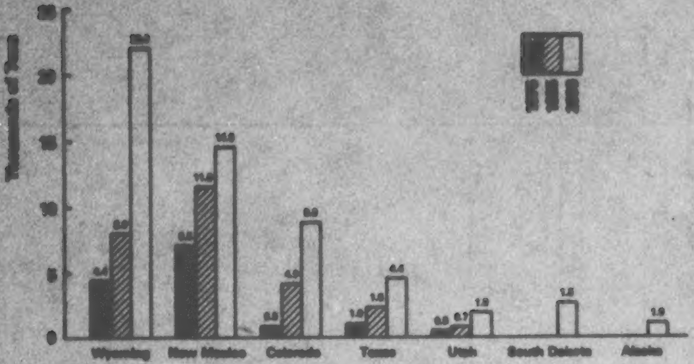

Figure 15: Uranium Extraction—Seven Largest Producers Year 2000

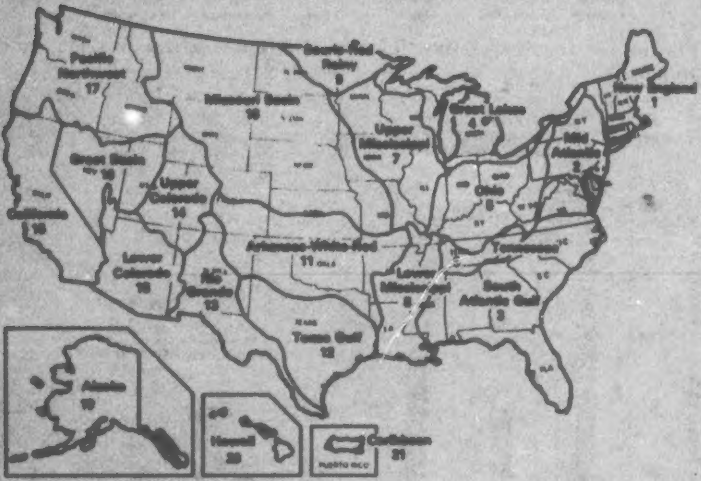
Pacific Northwest 17
Missouri Basin 10
Souris-Red-Rainy 9
Upper Mississippi 7
Great Lakes 4
New England 1
Mid Atlantic 2
Great Basin 16
Upper Colorado 14
California 18
Ohio 5
Arkansas-White-Red 11
Tennessee 6
Lower Colorado 15
Rio Grande 13
Lower Mississippi 8
South Atlantic Gulf 3
Texas Gulf 12
Alaska 19
Hawaii 20
Caribbean 21
PUERTO RICO

Figure 16: Water Resource Regions

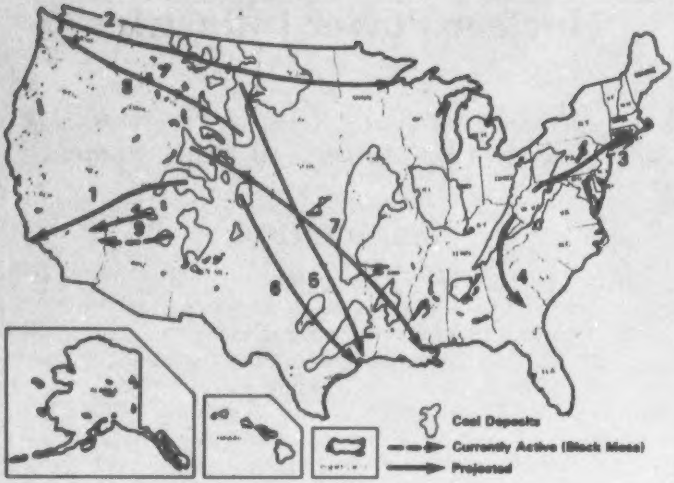
2
8
1
9
7
6
5
4
3
Coal Deposits
Currently Active (Black Mesa)
Projected

Figure 17: Major Coal Slurry Pipelines (Year 2000)

Update of Employment Trends in Nuclear Power Industries

Larry M. Blair, Manpower Research Programs, Oak Ridge Associated Universities, Oak Ridge, Tennessee

INTRODUCTION

Over two decades have passed since the United States initiated its Atoms for Peace Program to promote peaceful uses of nuclear energy as a national objective. During the 1970s nuclear energy-related activity grew more rapidly than the total economy in the United States. At present, however, uncertainties cloud the future of nuclear energy development.

The growth during the 1970s in nuclear energy-related activity in the United States is reflected in the growth in the number of firms reporting nuclear-related products and services; approximately 550 firms in 1969 versus over 1300 firms in 1978, an increase of 145 percent.[1] While much of this growth occurred in "major" areas of nuclear energy activity, e.g., the nuclear fuel cycle, power plants, reactor design and manufacture, and nuclear research, a large number of firms are engaged in many other related activities, e.g., nuclear facility maintenance, protective clothing, transportation and shipping, environmental monitoring equipment services, information services, and training of nuclear power plant personnel. In addition, other nuclear-related activities such as radioisotope products and radiography services, have continued to expand.[2] Over the last decade the United States nuclear energy industry matured and shifted from principally research and development activities to large scale commercial activities. The principal segments of nuclear energy production are shown in Figure 1.

Most of the data used in this paper have been collected by surveys annually from 1960 through 1970, and biannually from 1971 through 1977, by the Bureau of Labor Statistics of the U.S. Department of Labor under contract with the U.S. Department of Energy (and in the past, the U.S. Energy Research and Development Administration and the U.S. Atomic Energy Commission). The universe of firms is established by the U.S. Department of Energy and its contractor, Oak Ridge Associated Universities. The types of firms included in the survey universe

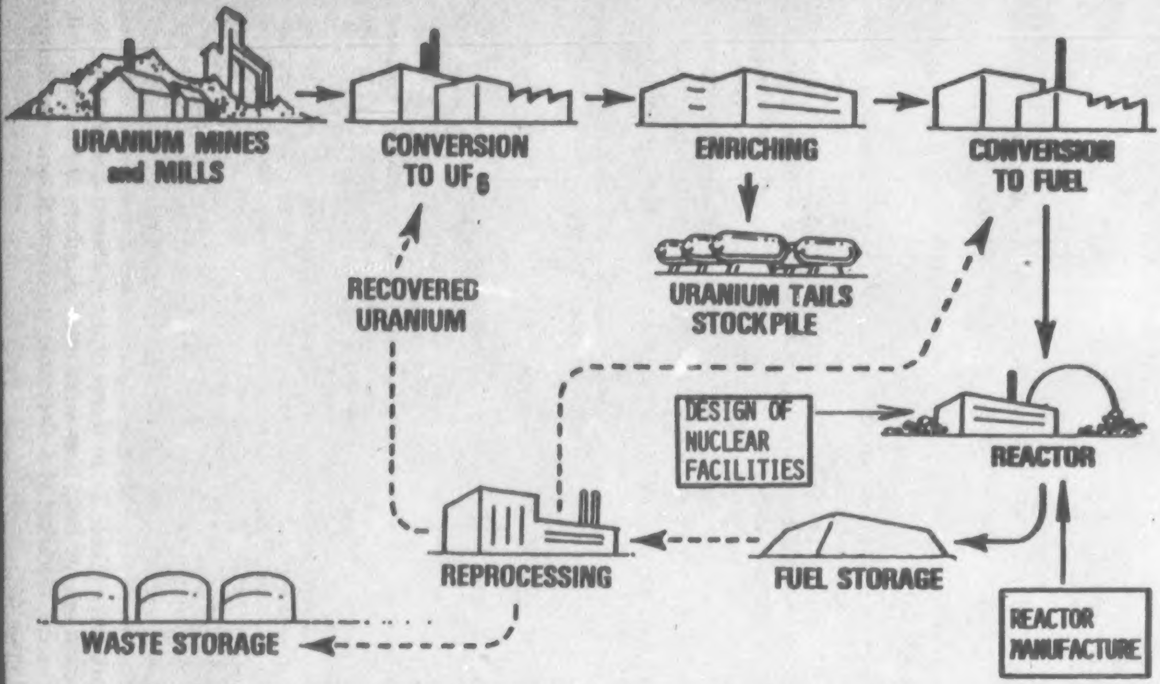
URANIUM MINES and MILLS
CONVERSION TO UF6
ENRICHING
CONVERSION TO FUEL
URANIUM TAILS STOCKPILE
RECOVERED URANIUM
DESIGN OF NUCLEAR FACILITIES
REACTOR
REPROCESSING
FUEL STORAGE
REACTOR MANUFACTURE
WASTE STORAGE

Figure 1: The Light Water Reactor Nuclear Fuel Cycle

and the survey questions have not changed significantly since the 1968 survey, permitting reliable comparisons to be made for the last ten years. The survey focuses on scientific, engineering, and technical-level positions.

This paper is divided into two sections. The first section reviews the employment trends in nuclear energy-related occupations over the last decade. The second section will speculate on near term labor needs in the nuclear energy field.

Nuclear Energy-Related Employment Trends During the 1970s

Reported employment in the United States' nuclear-related industry approached a quarter of a million workers in 1977 (Table 1). Nuclear energy-related employment grew at a moderate 1.8 percent continuous growth rate during the 1960s. The continuous growth rate was 3.7 percent during 1968-1973 and increased to 7.0 percent during 1973 through 1975. The employment growth during the 1975-1977 period indicates the growth rate leveled off at about 6½ percent.

TABLE 1: Nuclear-Related Employment in the United States, 1962–1977

	1962	1968	1973	1975	1977
Total Employment[a]	127,000	146,400	174,500	203,000	234,800

[a] The data referred to in this table and elsewhere in the paper excludes nuclear-related employment in government units, medical facilities, construction, and academic institutions. Based on preliminary examinations, the employment reported in the surveys (as shown above) represents at least 90 percent of the actual total survey universe employment in 1968 and approximately 95 percent in 1973, 1975, and 1977. Less is known about the 1962 survey, but it appears that it represents 90 to 95 percent of the total survey universe employment. These percentages are based on the 1977 universe scope.

Source: Data for the uranium mining and milling employment is from, *Statistical Data of the Uranium Industry*, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado. All other employment data is from, *Nuclear-Related Employment Survey*, U.S. Department of Energy and Bureau of Labor Statistics/U.S. Department of Labor, Oak Ridge Associated Universities Data Books, Oak Ridge, Tennessee.

Over the last 10 years the scientific, engineering, and technician work force has constituted about 43 percent of the total work force (Table 2). In terms of occupational distribution, the nuclear energy field uses substantial numbers of nuclear, civil, chemical, electrical and electronic, mechanical, and metallurgical engineers.

TABLE 2: Percentage Distribution of Nuclear-Related Occupational Employment for 1968 and 1977

Occupation	1968	1977
Total, engineers	16.0%	18.0%
Chemical	1.4	1.1
Civil	0.7	1.7
Electrical and electronic	3.6	3.4
Mechanical	5.3	5.1
Nuclear	1.9	2.5
Metallurgical	0.6	0.5
All other	2.4	3.7
Mathematicians	1.3	0.8
Total, physical scientists	6.8	4.3
Chemists	2.7	1.6
Physicists	3.1	1.8
Metallurgists	0.5	0.3
All other	0.4	0.6
Total, life scientists	1.2	1.5
Health physics	0.4	0.4
All other	0.7	1.0
Total, technicians	17.9	18.4
Drafting	3.3	4.2
Electrical and electronic	3.7	2.9
Other engineering	3.5	3.7
Physical science	1.8	1.2
Life science	0.4	0.3
Health physics	0.9	1.1
Reactor operator	0.6	1.8
All other	3.7	3.1
Other	56.9	57.1
Total[a]	100.0	100.0

[a] Column totals may not add to 100.0 percent because of rounding.
Source: See Table 1.

Total scientific employment increased slowly from 1968 through 1977. Nuclear energy-related employment for technicians increased substantially over the last ten years with draftsmen, other engineering technicians, health physics (radiation protection) technicians, and reactor operators all having relatively large employment increases.

As the nuclear energy industry matured and commercial applications expanded during the 1970s, the involvement of scientists and engineers in research and development activities decreased substantially (Table 3). Examination of the data for 1975 and 1977 indicates these percentages are probably stabilizing at close to the 1977 levels. About 80 percent of the scientists and engineers involved in research and development were employed in government-owned, contractor-operated facilities (i.e., U.S. Department of Energy national laboratories and specialized nuclear energy facilities).

TABLE 3: Nuclear-Related Engineers and Scientists Involved Primarily in Research and Development Activities, 1968–1977

	Percentage Involved in Research and Development		
Occupation Group	**1968**	**1973**	**1977**
Engineers	58.9%	33.8%	31.5%
Scientists[a]	82.5	70.3	66.9

[a] Includes mathematicians, physical scientists, and life scientists.

Employment in Selected Nuclear Energy Segments During the 1970s

Comparisons Between Segments. All of the major nuclear-related segments had large employment changes over the last ten years (Table 4). Establishments engaged primarily in research and development related activities reported an employment decrease of 33 percent between 1968 and 1973. However, employment in the research and development segment appears to have stabilized between 1975 and 1977. The other segments all reported substantial employment growth between 1968 and 1977.

The different employment growth rates for the various nuclear industry segments and the changing composition of work activities within the nuclear industry have caused major shifts in the distribution of scientific and engineering employment between the segments (Table 5).

Nuclear Fuel Cycle Segment. Total employment in the nuclear fuel cycle increased 150 percent between 1968 and 1977. A 10.1 percent continuous growth rate was attained for 1968-1973 and a 9.7 percent growth rate for 1973-1977. Approximately one-fourth of the workers in the nuclear fuel cycle in 1977 were scientists, engineers, and technicians. This percentage has varied slightly since 1968. Of the 2,740 engineers, two-thirds were in three engineering fields—chemical, mechanical, and electrical and electronic. Forty-five percent of the 1,180 scientists were chemists. The 4,100 technicians were distributed across most of the occupations, however, physical science technicians (32 percent) were, by far, the most common.

TABLE 4: Distribution of Employment for Selected Nuclear Segments, 1968–1977

	1968		1973		1977	
Segment	Number	Percent	Number	Percent	Number	Percent
Nuclear fuel cycle						
Mining and milling	6,100		5,000		13,000	
Conversion and enrichment	5,300		7,700		13,100	
Fuel fabrication, waste disposal, reprocessing, transportation and special materials	6,200		16,500		16,900	
Total	17,600	12.0	29,300	16.7	43,000	18.3
Power plant operation and maintenance	1,200	0.8	7,700	4.4	18,300	7.8
Reactor design, manufacturing	16,500	11.3	26,900	15.4	34,100	14.5
Design nuclear facilities	6,200	4.2	21,400	12.3	36,900	15.7
Nuclear-related research and development facilities[a]	54,500	37.2	37,000	21.2	36,500	15.6
Other	50,400	34.4	52,300	30.0	66,000	28.1
Total	146,400	100	174,500	100	234,800	100

[a] Includes research and development in nuclear energy, environmental and ecological research, biological and medical research, accelerators, reactor research and development, commercial laboratories, and health and industrial safety.

Power Plant Operation and Maintenance. Total employment in the nuclear power plant operation and maintenance segment increased over 14 times between 1968 and 1977 as the number of nuclear powered electric generating plants rapidly increased. The segment experienced a 37.2 percent continuous growth rate for 1968-1973 and a 21.6 percent continuous growth rate for 1973-1977. About 17 percent of the 1977 work force were engineers and only 1.5 percent were scientists. However, almost one-third of the work force (approximately 5,900) in this segment were technicians including reactor operators, radiation monitors, and instrumentation and control technicians. Also a large number (4,200 or 23 percent) were highly skilled maintenance craftsworkers. Table 6 shows the distribution of technician and skilled craft workers in nuclear power plants. Within this segment, about 83 percent of the work force are actually employed in nuclear power plant facilities and the remaining 17 percent in establishments providing services to nuclear power plants.

TABLE 5: Distribution of Engineers and Scientists Among Selected Nuclear Energy Segments, 1968–1977

	Engineers[a]				Scientists[a]			
	1968		1977		1968		1977	
Segment	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Nuclear fuel cycle	1,010	4.5	2,740	6.7	650	5.0	1,180	7.9
Power plant operation and maintenance	30	0.1	3,140	7.7	260	2.0	460	3.1
Reactor design, manufacture	4,430	19.6	7,550	18.5	830	6.4	720	4.8
Design nuclear facilities	2,890	12.8	12,770	31.3	230	1.8	870	5.8
Nuclear-related research and development facilities	9,190	40.6	5,590	13.7	9,400	72.2	7,340	49.0
Other	5,090	22.5	9,060	22.2	1,650	12.7	4,410	29.4
Total	22,640	100.0	40,850	100.0	13,020	100.0	14,980	100.0

[a] Columns for percentages may not add to 100.0 percent because of rounding.

Reactor Design and Manufacture. Total employment in the reactor design and manufacture segment increased by over 100 percent between 1968 and 1977. The segment experienced an 8.1 percent continuous growth rate for 1968-1973 and a 5.9 percent rate for 1973-1977. One half of the labor force were scientists, engineers, or technicians in 1968 compared to one-third in 1977.

TABLE 6: Job Classifications Within Nuclear Power Plants, Technician and Skilled Workers

Job Group	Percent
Reactor operations	
Licensed (senior and operator)	10.7
Unlicensed	
Journeyman	4.1
Helper and trainee	20.7
Maintenance electrician	
Senior and journeyman	6.5
Helper and apprentice	1.8
Maintenance Mechanic	
Senior and journeyman	14.0
Helper and apprentice	7.1
Maintenance, other	
Nonstandard craft and janitor	4.5
Instrument and control	
Senior and journeyman	8.9
Helper and apprentice	4.7
Health physics technician	
Senior and journeyman	7.6
Helper	1.6
Stores	
Journeyman storekeeper	0.9
Helper storekeeper	2.2
Administration	
Senior and journeyman clerk	0.3
Clerk helper	4.3
Not reported	0.1
Total	100.0

Source: The data was collected in the latter half of 1977 by the International Brotherhood of Electrical Workers (IBEW) in a survey of union locals in nuclear power plants. At the time of the survey, the IBEW represented approximately 60 percent of the United States nuclear power plants. Survey results were received from 1,804 workers in 30 of the 39 power stations represented by the IBEW. This is approximately a 60-percent response for the 30 stations that cooperated with the survey.

Engineering employment increased by 3,100 positions and technicians by 500 positions over the 10 year period.

In 1977, mechanical and nuclear engineers constituted five-eighths of the engineers while electrical and electronic engineers accounted for an additional 10 percent. Among scientists, physicists (39 percent), chemists (22 percent), metallurgists (10 percent), and mathematicians (13 percent) accounted for the vast majority of positions. All four scientific occupations had substantial employment reductions between 1968 and 1977.

Design of Nuclear Facilities. Employment in the design of nuclear facilities segment has increased by over 30,000 between 1968 and 1977—a 500 percent increase. The continuous growth rates were 19.8 percent for 1968–1973 and 13.6 percent for 1973–1977. Over 60 percent of the labor force are scientists, engineers, and technicians.

Among the 12,800 engineers in 1977, mechanical engineers constituted 28 percent, civil engineers 22 percent, electrical and electronic 16 percent, and nuclear engineers 12 percent. Civil engineer employment has grown relatively faster over the last decade than other engineers employment.

Metallurgists employment in the design of nuclear facilities grew rapidly from almost none in 1968 to 175 or 20 percent of the total scientists in 1977. A wide distribution of mathematicians, physical scientists, and life scientists were employed in 1977. Draftsmen accounted for two-thirds of all the technicians and other engineering technicians accounted for one-fifth.

The design of nuclear facilities segment underwent a major transition from relatively large research and development involvement in 1968 to very little by 1977. In 1968, 22 percent of all workers were involved in research and development. By 1977, only one percent of the workers (two percent of engineers and four percent of scientists) were involved in research and development.

Research and Development Facilities. Employment in firms involved in nuclear energy-related research and development decreased almost one-third between 1968 and 1973, but remained fairly constant between 1973 and 1977. The percentage of employment accounted for by scientists, engineers, and technicians increased from 56 percent to 60 percent between 1968 and 1977. This segment has 50 percent of all the scientists (7,340 of 14,800) employed in nuclear energy. All types of engineers, scientists, and technicians are well represented in this segment. Establishments in this segment accounted for approximately 80 percent of all workers involved in nuclear-related research and development activities in 1977.

Summary of Recent Employment Trends

Most of the nuclear energy segments participated in the strong, overall growth in the United States' nuclear energy industry over the last decade. The exception is the segment containing firms engaged primarily in nuclear energy-related research and development activities where employment decreased substantially between 1968 and 1973. The growth in the nuclear industry reflects a movement to large scale commercial activities. In 1977, most industry segments appeared to be rapidly approaching what may be described as a mature production stage with the emphasis primarily on commercial activities rather than research and development which was the major emphasis in 1968.

The transition from a major involvement in research and development to primarily production activities did not change the percentage of employment for scientists, engineers, and technicians in the overall industry. Nuclear energy-related work still requires a relatively highly skilled, highly educated and trained labor force. The types of personnel required shifted somewhat. For example, there was an expanded relative need for civil engineers, nuclear engineers and draftsmen, as activities in the design of nuclear facilities and reactor design and manufacture segments rapidly expanded. It appears that the labor force composition by occupation stabilized in the latter half of the 1970s.

Near-Term Employment Requirements in Nuclear Energy

Despite statements from the administration that nuclear power must and will continue to be part of the United States energy program a realistic view of the near-term future of the nuclear energy industry in the United States must be one of great uncertainty and quite moderate overall employment growth expectations, especially relative to the 1970s. Questions about public health and safety have received a great deal of attention since the accident at the Three Mile Island facility. In addition, concern about environmental effects, unresolved issues and policies for waste disposal and reprocessing, actual and proposed state and federal moratoriums of new nuclear power plant construction and operations, reductions in export sales because of concern about nuclear weapons proliferation and because of increased foreign competition, rapidly increasing construction costs, changes in required power plant design and engineering, and a reduction in forecasted growth in electricity requirements all contribute to the present uncertainties and reduce the growth in the nuclear energy field.[3]

At best, employment growth in the first half of the 1980s in most of the nuclear energy segments will be moderate with actual declines probable in the reactor manufacturing, design of nuclear facilities, and nuclear research and development facilities segments. The one exception may be in actual nuclear power plant operations and maintenance where a relatively large number of power plants are still scheduled to begin operating in the early and mid-1980s.

Nuclear Fuel Cycle Employment in the Near-Term. Employment in uranium mining and milling grew very rapidly during the 1970s because of increased demand for uranium ore and because of decreases in labor productivity (between 1973 and 1978, output per worker decreased by over 50 percent in mining and by over 25 percent in milling).[4] In 1977, 30 percent of the nuclear fuel cycle employment was in mining and milling.

While employment in mining and milling is expected to continue to grow because of needs in existing mines, labor turnover, and some expansion in activity,[5] the prospects are for slower growth. Uranium exploration activity is currently expected to be reduced substantially and the rate at which additional mines are scheduled to be opened is expected to be rather drastically slowed.[6] Mining and milling activities require relatively few engineers, scientists, and technicians.

Employment in facilities converting uranium-oxide to UF_6 and in facilities engaged in enriching uranium accounted for about 30 percent of the uranium fuel cycle work force. Over 95 percent of the conversion and enrichment work force is in government-owned, contractor-operated facilities. Only three of these contractor-operated facilities are involved in enrichment activities and account for most of the employment. Most of the fuel conversion work force is in two relatively small, privately owned facilities (less than 500 employees in total).

During the 1970s employment grew by almost 150 percent in conversion and enrichment activities, however, most of this growth was in the three contractor-operated enrichment facilities. In the near-term, indications are that employment in conversion and enrichment will experience, at most, slow growth. A new contractor-operated enrichment facility (using a centrifuge technology rather than gaseous diffusion as in the existing plants) is scheduled to start operating in the mid-1980s and reach a total operating and maintenance work force of approximately 2,500 by 1990. However, employment reductions of almost 2,000 workers will occur in the early 1980s in the existing enrichment facilities related to the completion of technological upgrading programs. The conversion and enrichment facilities employed approximately 1,050 engineers, 450 scientists, and 840 technicians in 1977.

In 1977, forty percent of the fuel cycle employment was in fabrication, waste disposal, chemical reprocessing, transportation, or special materials production. As can be seen in Table 4, very little employment growth occurred in these areas of the fuel cycle between 1973 and 1977.

Slightly over one-half of these employees are in government-owned, contractor-operated facilities involved in waste disposal and reprocessing activities. In 1977, eight privately-owned establishments involved in fuel fabrication employed approximately 2,750 people which was a decrease of almost 1000 employees since 1975.

Any estimate for employment trends in even the near-term for these activities is very uncertain because of the large percentage of employment in the contractor-operated waste disposal and reprocessing facilities. While some new activities are currently being planned in the transportation and waste disposal areas many issues and a specific program are still being debated. Reprocessing of nuclear waste from electric generating power plants has been suspended for the present. Employment in the private sector fuel fabrication facilities is not expected to grow in the near future.

Power Plant Operations and Maintenance Employment in the Near-Term. Employment related to power plant operation and maintenance increased by approximately 17,000 positions during the 1970s as over 60 new power plants began operating, as maintenance employment needs at existing plants expanded somewhat, and as a nuclear power plant service industry developed. Unless a moratorium is imposed on nuclear power plants, information as of the end of December 1979 indicates that another 10 to 12 plants should begin operating in 1980 and another 50 between 1981 and 1986.[7] These new operating plants plus probable expanded needs for maintenance and safety personnel at existing plants indicates a very large increase in employment (perhaps close to doubling 1977 levels) over the next half decade in the nuclear power plant operations and maintenance segment. One survey also indicated relatively high turnover rates among nuclear power plant staff.[8]

In 1977, over 3,100 engineers and almost 5,600 technicians were employed in the nuclear power plant operation and maintenance segment. Table 7 provides information on the educational background of technician and skilled craft workers in nuclear power plants in 1977.

Reactor Design and Manufacturing Employment in the Near-Term.

Employment in reactor design and manufacturing more than doubled during the 1970s. The expected employment trends for the near future are, however, quite the opposite. Recent slowdowns in many power plant construction schedules, postponement or cancellation of several planned plants, and a sharp decline in plans for new plants for the late 1980s and early 1990s, plus a lack of new foreign orders all combine to strongly indicate substantial employment decreases in the reactor design and manufacture segment in the near-term. In fact, one facility which employed over 800 persons in 1977, currently has only about 200 employees and has announced a complete shutdown by the end of February 1980. In addition, a recent study reports that two major reactor manufacturers will probably cease manufacturing reactors in the near future and just provide service for reactors already sold.[9]

In 1977, this segment employed 18.5 percent (7,550) of all engineers and almost 5 percent (720) of all scientists in the nuclear field. Also, 3,300 technicians were employed in reactor design and manufacturing in 1977. Thus, a decline in employment in this segment would have major adverse impacts on nuclear-related job opportunities for engineers, scientists, and technicians.

Design of Nuclear Facilities Employment in the Near-Term. Employment in the design of nuclear facilities increased by over 30,000 positions during the 1970s reaching 36,900 in 1977 (a 19.8 percent continuous growth rate for 1968–1977). Virtually all of the employment in this segment is in the private sector with utilities and nuclear reactor firms being the major employers. In 1977, the design of nuclear facilities segment employed 12,770 engineers or over 30 percent of all engineers in the nuclear-related field. In addition, 870 scientists and over 9,000 technicians were employed in this segment in 1977. Thus, the design of nuclear facilities is a very important employment source for engineers and technicians in the nuclear field.

Estimating future employment trends for this segment, even for the near-term, is very difficult. There have not been any recent informational reports or studies specific to current employment or activity in this segment. Past studies have indicated a very high direct correlation between the number of power plants under development and employment in this segment.[10] Given the slowdown in current nuclear power plant construction and in planned power plant expansion for the late 1980s

TABLE 7: Power Plant Technician and Skilled Craft Workers, Highest Level of Schooling Completed, 1977

Highest Level of Schooling	All Technician and Skill Craft Workers	Job Groups			
		Operators[a]	Maintenance[b]	I&C[c]	Health Physics
Less than high school graduate	2%	1%	4%	0%	1%
High school graduate or equivalent	41	41	52	23	26
1–4 years college, no bachelor's degree[d]	52	55	42	69	61
4 years college, bachelor's degree	5	5	2	8	12
	100	100	100	100	100

Source: See Table VI.

[a] Includes licensed and non-licensed reactor operations staff.

[b] Maintenance includes electricians, mechanics, and other.

[c] Instrumentation and control technicians.

[d] Includes persons holding an associate degree from a two-year college.

NOTE: Columns may not add to 100 percent because of rounding.

and early 1990s, it would seem likely that employment in the design of nuclear facilities segment would grow slowly and, perhaps, could even slightly decline over the next several years. Thus, the tremendous increase in job opportunities for engineers and technicians that occurred in this segment in the 1970s does not appear to be likely to continue in the 1980s as employment in these positions will probably grow slowly or moderately at best.

Nuclear-Related R&D Facilities Employment in the Near-Term. Employment in nuclear-related R&D facilities remained practically constant at about 37,000 between 1973 and 1977 after decreasing from over 54,000 in 1968. This segment employed about 14 percent (5,590) of all engineers and almost 50 percent (7,340) of all scientists in the nuclear field in 1977. In addition, over 8,800 technicians were employed in this segment in 1977. Establishments reporting in this segment accounted for 44 percent of all the scientists, engineers, and technicians who were primarily engaged in R&D activity in the nuclear field. Within the segment 75 percent of the 1977 employment was in government-owned, contractor/operated facilities. Approximately 60 percent of the employment in this segment was in facilities where primarily the R&D focus was specifically nuclear energy.

As noted, employment in this segment did not increase during the 1970s. In the near-term a similar no growth pattern is likely to persist with some likelihood existing for an actual employment decrease. The President's proposed budget for fiscal year 1981, calls for a substantial decrease in spending for nuclear energy-related research and development (a 24 percent decrease before allowing for inflation).[11] Past studies have shown that the level of real government expenditures on nuclear-related R&D explained about 60 percent of the variance in nuclear-related R&D employment in the contractor-operated facilities[12] which would indicate a considerable decrease in employment in this segment resulting from the President's proposed budget. However, indications are that Congress will attempt to establish expenditures for nuclear energy R&D closer to recent funding levels (as they have done for the past two years). Thus, the likely result of government funding for nuclear energy R&D will be to maintain recent employment levels.

In the private sector, which has only ¼ of the employment in this segment, most of the positions are in facilities involved in nuclear energy R&D (2,260), reactor R&D (1,920), commercial laboratories (1,320), environmental and ecology work (1,310), biological and medical work (1,170), and health physics and safety work (460). With perhaps the exception of the nuclear energy and reactor R&D activities, these private sector related facilities should at least maintain or more likely moderately increase their employment levels.

Expectations for the near-term for employment trends in nuclear-related R&D facilities must be a continuation of the mid-1970s levels, i.e., little or no growth in positions with a likelihood of some job erosion in the contractor-operated facilities involved in nuclear energy R&D. Also, the decrease in reactor activity in the private sector would seem to indicate some job loss in private facilities involved in reactor R&D and in nuclear energy R&D.

Summary of Employment Trends in the Near-Term. Attempting to examine even the near-term future of the U.S. nuclear industry is quite difficult. The increase in the number of operating nuclear power plants appears likely to continue through the mid-1980s and will require substantial additional employment in the new plants and in firms providing various power plant maintenance and other services. Also, employment in uranium mining and milling should continue to increase in the near-term but at a more moderate rate than that experienced in the latter half of the 1970s.

TABLE 8: Summary—Near-Term Employment Trends Expectations for Selected Segments of the Nuclear-Related Field

Segment	Near-Term Employment Expectation	Remarks
Nuclear fuel cycle Mining and milling	Moderate growth	Some reduction in activity expansion announced. Relatively few scientists, engineers and technicians. Most activity located in mountain states in the west.
Fuel conversion and enrichment	Slow growth	95 percent of employment in contractor-operated facilities, most of which is in 3 enrichment plants.
Fuel fabrication, waste disposal, reprocessing, transportation, special materials production	Probably no growth	Little employment growth in the mid-1970s. Almost 50 percent of employment in contractor-operated facilities. Many unresolved issues with respect to waste disposal. No reprocessing permitted at present for electric power plant waste. Employment in private sector fuel fabrication decreased in mid-1970s.
Power plant operation and maintenance	Rapid growth	Even after slowdowns and postponements, latest estimates indicate number of nuclear power plants in operation will double by 1986 or 1987.

Reactor design and manufacture	No growth at best, probably significant reductions	Evidence indicates some employment decline at present. Large numbers of engineers and technicians work in this segment.
Design of nuclear facilities	Slow growth at best, possibility of some decline	Difficult segment to review. Employs large numbers of engineers and scientists.
Nuclear-related R&D facilities	Little or no growth, very possible to have actual decline	75 percent of employment in contractor-operated facilities. President's proposed budget calls for funding decrease for nuclear energy R&D. 50 percent of all scientists in nuclear-related field in this segment plus large numbers of engineers and technicians.

The employment trend estimates provided in this paper for the rest of the nuclear field are for little or no growth with strong likelihoods of decreases in the areas of reactor design and manufacturing and nuclear-related R&D facilities. These estimates obviously reflect little optimism for growth, at least in the near future, in the U.S. nuclear industry. This view does not appear to be realistic based on the weight of evidence including recent studies and industry statements, actual current trends in industry activities and announced plans, the current uncertainties faced by the industry, and the unresolved issues and governmental policies.[19]

The majority of the nuclear field employment for scientists, engineers, and technicians is found in three segments—reactor design and manufacture, design of nuclear facilities, and nuclear-related R&D facilities. The future of the design of nuclear facilities and reactor design and manufacture segments is obviously related to power plant development. A reduction in nuclear power plant development for any extended length of time would probably cause a significant decrease in activity and employment in these two segments, which accounted for over 30 percent of the total employment in the nuclear industry in 1977. Both of these segments employ a large number of scientists, engineers, and technicians with specialized skills.

Much of the nuclear-related research and development activities are government-funded, and the vast majority of the activity located in government-owned, contractor-operated facilities. Obviously the future of nuclear-related research and development depends primarily on future levels and directions of government funding.

Table 8 provides a summary of the near-term employment trend expectations for selected segments in the nuclear field.

REFERENCES

1. *Nuclear News Buyers Guide* , Mid-February, 1978.
2. U.S. Department of Commerce, Bureau of the Census, *Current Industrial Reports, Selected Atomic Energy Products*, MA-38Q.
3. See, for instance, *Commercial Nuclear Uranium Market Forecasts for the United States and the World Outside Communist Areas*, U.S. Department of Energy, Energy Information Administration, DOE/EIA-0184/24, Order No. 556, January 1980; *Energy Users Report*, Number 339, February 7, 1980, p. 10; and *Nuclear News*, Vol. 23, Number 2, February 1980, p. 88.
4. Larry M. Blair, Sharon E. Bell, and Gary L. Hodgin, "Employment and Labor Requirements in the Uranium Fuel Energy Segment, A Working Paper," unpublished draft report prepared for SERI, Manpower Research Programs, Oak Ridge Associated Universities, Oak Ridge, Tennessee, September 1979.
5. "A Manpower Gap at Uranium Mines," *Business Week*, November 7, 1977, p. 32, and personal discussions with staff of uranium mining firms.
6. "The Glow Has Faded From Uranium Mining," *Business Week*, pp. 63–64.
7. For 1980, see *Energy Users Report*, Number 339, February 7, 1980, p. 8. For 1980 through 1987, see *Nuclear News*, Vol. 23, No. 2, February 1980, p. 30.
8. Kaiz, Gerald Howard, "Nuclear Plant Staff Turnover," Industrial Training Corporation, 1416 Southlawn Lane, Rockville, Maryland 20850, paper presented at the American Nuclear Society Meetings, August 7–10, 1977, Chattanooga, Tennessee.
9. *Nuclear News*, Vol. 23, Number 2, February 1980, p. 88, review of *Nuclear Energy: Dark Outlook*, by William Stoops, Roger Copland, and Adam Sisminski of Washington Analysis Corporation.
10. Larry M. Blair, "Occupational Employment Trends in Selected Nuclear Industry Segments in the United States," paper number IAEA-SM-238/21 presented at the International Symposium on Manpower Requirements and Development for Nuclear Power Programmes sponsored by the International Atomic Energy Agency, Saclay, France, April 2–6, 1979, Oak Ridge Associated Universities, Oak Ridge, Tennessee.

11. *Appendix, The Budget of the United States Government, Fiscal Year 1981*, U.S. Government Printing Office, Washington, D.C., pp. 399–400.
12. Joe G. Baker, *An Examination of Employment in the Atomic Energy Field*, ORAU-139, Oak Ridge Associated Universities, Oak Ridge, Tennessee, February 1978, p. 73.
13. See sources listed in 3, 6, 7, 9, and 11.

Forecasting Construction Labor Requirements for Powerplants

William F. Hahn, U.S. Department of Labor, Washington, DC

INTRODUCTION

This paper reports on an innovative research program of the U.S. Department of Labor, the Construction Labor Demand System (CLDS) and its analyses of future labor needs for constructing the nation's powerplants.

The title "Construction Labor Demand System" (CLDS) is often used interchangeably to identify an operating research unit of the Department of Labor focusing on construction and energy issues and a state of the art labor market information and forecasting system, developed and operated by that unit.

CLDS is a computer based information system designed to support analyses of labor market conditions in local regions. The system enables users to monitor ongoing construction activity in each region as well as provide forecasts of future construction activity and labor requirements.

As is quite well-known, construction activity commonly varies to a considerable extent annually, seasonally, and geographically and the industry adapts well to variations in demand. The flexibility of the industry allows it to respond admirably to most conditions.

However, even with the high degree of ability of the construction labor force and the flexibility of the industry, serious problems can arise when massive changes in volume or composition are presented.

Construction of energy facilities represents a relatively small part of the total annual utilization of the construction work force, perhaps ten percent. However, individual projects are often so large in size in this sector that they may have drastic impact on local and regional labor markets.

The CLDS program has unique capabilities with respect to energy related construction. One of the objectives in initiating the effort in 1977 was to develop for the participating Federal agencies a capability to assess the labor and other resource requirements of alternative U.S. energy development scenarios.

To accomplish this goal, the CLDS staff maintains a continuously updated computerized file of all planned and on-going energy projects in the U.S. (electric generating plants, transmission lines, and fuel extraction, processing, and transportation facilities). Under authority granted to CLDS by OMB, each energy project is monitored; project stocks are converted into time-phased flows of labor requirements—construction, operation and maintenance.

Powerplant Construction

In September 1979 CLDS produced a study for the Departments of Energy and Labor, the objective of which was to establish a consistent set of base-line estimates of future capital costs and labor requirements for power plant construction which could be used by them as well as utilities, constructors, labor organizations, industry vendors, and the general public for policy-making and planning purposes. The need for this type of research is quite apparent given the nation's energy demands and the substantial resource requirements associated with power plant construction.

Separate projections for nuclear, hydroelectric, and fossil-fueled electric generating facilities were included. Within each category, estimates of on-site labor requirements were provided for 14 separate craft classifications. Projections were also presented for each of 10 geographical regions of the United States.

The estimates were based upon cost and other data collected on power plants already under construction as well as those in advanced planning stages which were expected to be under construction during the 1979-1983 interval. To develop the data base estimates the CLDS staff conducted a special survey of utilities in March and April of 1979. A new survey will be undertaken shortly and the survey form is reproduced as Appendix A.

The forecasting method employs ten labor profiles developed by CLDS on the basis of industry experience in the mid and late 1970's. These profiles depict average time-phased manning requirements by trade (29 crafts) for construction of coal, oil, gas, and nuclear electrical generating facilities. The profiles convert megawatts into average craft requirements phased over an estimated duration (25 phases of construction duration). The profiles are applied to all nuclear, coal, oil, gas and hydroelectric generating facilities either presently under construction or planned for future construction.

The data source for fossil-fueled and hydroelectric units is the

Energy Department's Generating Unit Reference File. This file, which is updated semiannually by CLDS questionnaires to the utility companies, provides all plant and location characteristics necessary to generate manpower requirements.

The data source for all nuclear electric generating facilities, either presently under construction or planned for future construction, is the Construction Status Report of the Nuclear Regulatory Commission's Office of Management and Program Analysis. This file, which is updated monthly by NRC, provides all plant and location characteristics necessary to generate manpower requirements.

These data sources were used in a pragmatic manner to develop as consistent and reliable a set of historical data as possible. As with most forecasting efforts, data availability delimits the techniques that may be used in the forecasting process.

The Forecasts

There are significant differences in the skill requirements needed for constructing each type of power plant facility, although workers in all the major crafts will be needed on all types. Asbestos workers and boilermakers, for example, are needed in much greater numbers in fossil-fueled plant construction than on nuclear jobs. Pipefitters, on the other hand, are needed in greater number in constructing nuclear generating facilities.

The utility industry's shift in the late 1970's from an emphasis in new construction on nuclear to coal-fired plants will be reflected in occupational employment patterns in the 1980's. At any point in time, labor involvement will be a function of the interrelation of activity, construction phase and categorical mix.

We estimate that power plant construction in the 1979-1983 period will require a total on-site labor requirement of 881,790 work-years (1,929.2 work-hours per year). Actual employment levels will depend upon several factors, the most important among them being the scheduling of resources to meet availability of craftsmen, extent of shift work, overtime allowed and actual physical progress on the job. Labor requirements are forecasted to decline each year through the period, dropping by about 30 percent from an annual average of 200,330 work-years in 1979 to 142,840 work-years in 1983 (Table 1).

The forecasted decline in labor needs will parallel a downward trend in the number of electric generating units under construction or planned during the period. On an electric capacity basis, approximately 252,000 megawatts are associated with construction projects under way or planned in 1979. This is projected to fall to about 185,000 megawatts in 1983 (Figure 1).

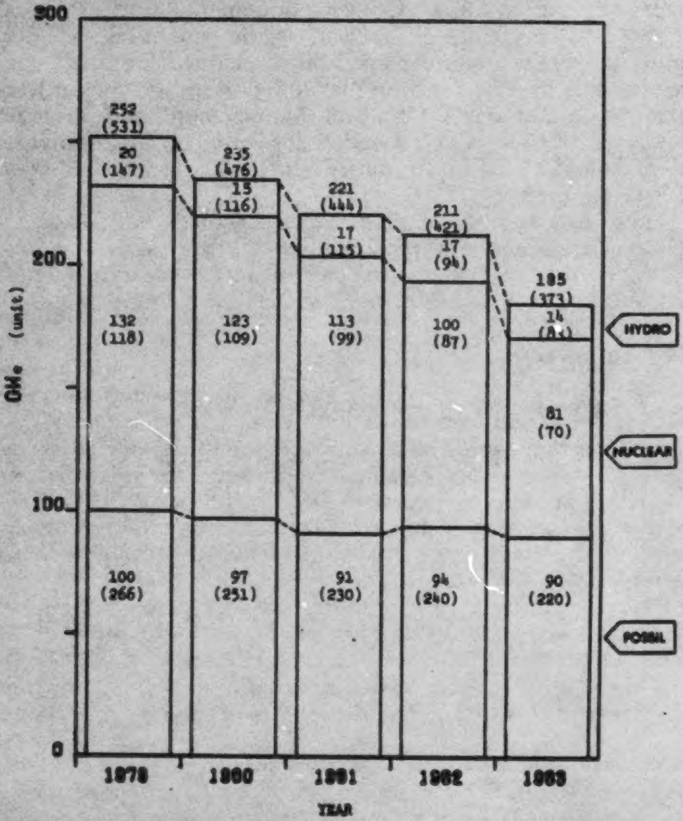

Figure 1: New Electric Generating Capacity Under Construction (as of September, 1979)

The increasing concerns over safety, reliability, and environmental protection has led to a substantially enlarged scope of work for constructing electric power plant generating stations. This development is reflected in increasing costs per kilowatt installed for power plant construction and a concomitant dampening of demand for electricity. Also contributing to rising costs per KWe have been higher financing costs and escalation of labor, materials, and equipment costs.

TABLE 1: Labor Requirements for Constructing Electric Generating Powerplants in the U.S., 1979–1983 (work-years)[1]

Craft	1979	1980	1981	1982	1983	Total	% Change 79-83
Pipefitters	42,170	45,070	42,020	36,370	32,350	197,980	-23.3
Laborers	31,720	29,490	26,570	22,350	19,370	129,500	-38.9
Electricians	27,440	29,820	28,030	24,790	22,510	132,590	-18.0
Carpenters	23,720	21,020	17,790	15,100	12,940	90,570	-45.5
Iron Workers	17,800	16,220	14,020	12,150	11,170	71,360	-37.2
Operating Engineers	15,740	14,690	13,070	11,440	10,270	65,210	-34.8
Boilermakers	14,280	13,850	12,810	11,970	12,390	65,300	-13.2
Truck Drivers	7,840	7,700	6,730	5,650	4,950	32,870	-36.8
Millwrights	4,970	5,440	5,270	4,650	4,280	24,610	-13.9
Painters	3,690	4,020	4,030	3,530	3,140	18,410	-15.1
Asbestos Workers	3,440	3,730	4,150	3,910	3,770	19,000	9.4
Sheet Metal Workers	2,750	3,140	3,120	2,820	2,600	14,430	- 5.6
Cement Masons	2,750	2,650	2,360	2,020	1,810	11,590	-34.3
Other Workers	1,220	1,170	1,010	910	810	5,120	-34.1
Bricklayers	790	730	670	560	480	3,230	-39.0
Total Workers	200,330	198,740	181,660	158,220	142,840	881,790	-28.7

---

[1] Work-years (37 hrs./wk., 4.345 wks./mo., 12 months) = 1,929.2 work-hours/year.

NOTE: Due to rounding, sums of individual items may not equal totals.

An important factor affecting costs has been the steady increase in construction duration for nuclear power plants. The average construction duration for nuclear units (1200 MWe) beginning construction in 1974 was 100 months and for those started in 1985 is forecasted to be 120 months. The cost-duration relationship is complicated by the fact that construction duration has, in some instances, been voluntarily delayed by utilities due to slower growth in demand for electrical energy than was originally anticipated and because of a need to minimize current capital outlays.

In contrast to nuclear construction costs, projected costs for coal-fired plants show lesser increases, although the additions of scrubbers for sulphur dioxide removal will increase their costs by about 20 percent.

Unit work-hour requirements for nuclear power plants are expected to grow at annual compound rates of 5.2 percent, 3.5 percent, and 1.5 percent during 1968–1974, 1975–1979, and 1980–1985 respectively. Nuclear units constructed in the South are expected to require about 18 percent fewer work-hours per KWe of installed capacity than those in the non-South.

We estimate annual compound growth rates of unit work-hour requirements for coal-fired plants are at 3.3 percent and 1.4 percent during 1974–79 and 1980–1985, respectively. Units constructed in the South are estimated to require approximately 12 percent fewer work-hours per kilowatt of installed capacity than those in the non-South.

Among construction trades, pipefitters, electricians carpenters, and ironworkers will be the most extensively utilized crafts with requirements totaling 197,980, 132,590, 90,570, and 71,360 work-years respectively during the 5-year period. Requirements for workers in these crafts and most of the other trades will ease during the first half of the 1980's as power plant construction activity declines from a pace set in the late 1970's.

Requirements for workers in fossil-fueled power plant construction projects are projected to decline by 11 percent in the 1979–1981 period and then rebound, bringing the overall requirement in 1983 to a level about 1 percent higher than the base year of 1979. Labor requirements on nuclear construction jobs, on the other hand, are expected to grow by some 5,000 work-years between 1979 and 1980 and then decline sharply through 1983. Total requirements in the latter year are anticipated to be only about 55 percent of the demand in 1980. As a proportion of the overall power plant construction work force, nuclear is projected to decline from about 63 percent in 1980 to slightly less than 50 percent in 1983.

Nearly two-fifths of the labor requirements associated with power plant construction during the next five years will be centered in the Southeastern and Midwestern sections of the country. But even here, construction labor requirements are projected to fall by more than one-third during this time frame. In only two areas of the nation, New York-New Jersey and the Rocky Mountains are increases in on-site labor needs forecasted between 1979 and 1983.

The projections discussed in this report are short-term in nature—going out only through 1983. To a considerable degree, they reflect events of the later 1970's when considerable capacity came on-line to swell a reserve margin that already might have been too high. The estimates also reflect nearly five years of stretching out of construction programs as capital costs escalated dramatically.

We believe that reserves in most regions of the nation will still be high for most of the 1980's and the derived demand for construction labor will continue to contract. However, late in the decade, 1988–89, an upsurge in construction of fossil-fueled units is likely to take place as reserve margins are sliced and utilities need to replace older generating units. The future of nuclear plant construction is more hazy but there would seem little to suggest renewed growth until some time in the 1990's.

Future CLDS Forecasting

CLDS is now developing methodologies that will allow reliable labor demand forecasting for periods of time greater than in the current study—10 years or more in the future. This effort will most likely involve an interface of the CLDS model with the Electricity Supply Model of the Electric Power Research Institute (EPRI). A linear programming model, the EPRI model, given an electric demand forecast, generates the optimum generation expansion path over the planning horizon. The sharing of new generation capacity by type are derived from an econometric estimation of observations of individual utilities. New additions are estimated as functions of relative costs of each plant type.

CLDS will convert the added capacity additions identified by the EPRI model into time-phased flows of manual and technical labor needed to construct the facilities.

APPENDIX A: MAJOR ENERGY PROJECT SURVEY

1\. a. Name of Utility Company ______________________________

b. Name of Power Plant and Units included in this report ____________________

______________________________ ____________________
Unit Number(s)

c. Type of Project Organization and Contracting Method (Check only those that apply):

- ____Owner Engineered and Constructed
- ____Owner Engineered
- ____Owner Construction Managed
- ____Single Company Engineer/Constructor
- ____Single Company Constructor/Construction Manager

d. Major Method of Construction Contracting (Check one only):

- ____Force Account
- ____Time & Materials & Fee Arrangement
- ____Firm Unit Prices
- ____Lump Sum/Fixed Price

e. Percentage of Engineering completed or planned to be completed before construction start ________%

f. Duration or expected duration from start of engineering to receipt of permit to construct the facility ______________months

2\. What is the most recent estimate of the cost of the project to the owner (including escalation)?

a. Field Construction Cost (INCLUDE: site preparation, amount paid to all contractors and subcontractors, materials and components furnished by owner, work performed by owner's employees assigned to the project site, and estimated cost of donated materials. EXCLUDE: land and pre-existing buildings, contingency funds, furniture, furnishings, and other movable equipment.) $ ______________

b. Land Cost $ ______________

c. Architectural and Engineering Design Costs (INCLUDE: all fees for architectural and engineering services, cost of design work by owner's staff.) $ ______________

d. Interest Cost during construction $ ______________

e. Home Office Cost (INCLUDE: taxes, project owner's overhead and office costs, fees (other than A/E services), and all other miscellaneous costs allocated on owner's books.) $ ______________

f. Estimate of Total Cost to Owner (Sum of a, b, c, d and e.) $ ______________

g. Date estimate was made: ______________
month/year

3\. Will the majority of the work force be covered by a union contract? ___yes ___no

4\. What is the most recent estimate of completion date of the project?

Unit Number	Engineering Start Date	Construction Start Date	Completion Date
__________	__________	__________	__________
__________	__________	__________	__________

APPENDIX A: (cont.)

________ ________ ________ ________

________ ________ ________ ________

5. If fossil, does this unit(s) include Flue Gas Desulphurization (FGD) equipment?

____yes ____no

a. If yes, what percent of total cost is attributable to the addition of FGD?

________%

b. If yes, does the cost estimate include costs associated with waste disposal regeneration, etc. ________________

6. If coal-fired, originally was the planned primary fuel for this unit(s) gas or oil?

____yes gas ____no
oil

a. If yes, why was the primary fuel changed to coal?

Expected market conditions
Statutory prohibitions
__ anticipated
__ actual

Other (please explain): ________________________

____

Strengths and Pitfalls in Doing a Needs Assessment in Emerging Energy Technologies

Marcus C. King, Pitt Community College,
Greenville, NC

ENERGY TECHNOLOGY MANPOWER SURVEY

One basis upon which educational programs should be planned is an assessment of anticipated employment needs for expected graduates of the program. Pitt Community College, in its effort to maintain its progressive institutional development and also to provide trained individuals for evolving technologies and jobs, completed a quantitative assessment of the labor market demands for graduates of an energy technology program in the Fall of 1978.

The manpower study was undertaken in conjunction with the overall energy education development project funded by the Energy Division of the North Carolina Department of Commerce. The research effort to determine the job market potential of graduates of an energy technology program included the following activities:

1) define and designate sample population
2) design and print survey instrument
3) mail surveys to recipients
4) follow-up on unreturned surveys
5) tabulate returns
6) analyze results and write-up findings

It was impossible to sample every potential employee in North Carolina; therefore, the study involved the utilization of a reasonable sampling technique using a stratified random sample with concentration in North Carolina and major emphasis on the geographical area east of Greensboro, North Carolina.

Within the state, the following types of potential employers were asked for current employment data and opinions on whether or not they would probably employ a graduate of the program and estimates of potential job openings. The areas surveyed included: Industrial, Government, Commercial, Education, Contractor, Professional, and other.

A representative random sample of each type of entity was questioned. A project response rate of 20–30% was anticipated. The sample included 812 surveys, of which 152 or 18.7% were returned.

The actual sample was composed of the following:

	Mailed	Returned	Percent
Industrial	289	58	20
Government	138	36	26.1
Commercial	26	11	42.3
Education	15	9	60
Contractors	189	13	6.8
Professional	28	7	25
Other	127	18	14.2
	812	152	18.7%

The manpower instrument was not only designed to survey the job market but also to determine the area where the manpower needs were the greatest. Four areas were included as follows:

1) Energy Management
2) Energy Conservation
3) Solar Energy
4) Alternate Energy.

The questionnaire was designed to elicit the following types of data:

1) Current information on the respondent as to type firm, agency, or organization.
2) Principal business or service offered.
3) Size of workforce.
4) Evaluation of four major areas listed.
5) Current energy related positions.
6) Projected need to hire energy related personnel.
7) Estimate of actual energy related jobs.
8) Interest in employing a graduate of an energy technology program.

A survey is intended to be extensive and cross sectional dealing with a relatively larger number of cases at a particular time and yielding statistics that are abstracted from particular cases.

The survey method gathers data from a relatively large number of cases at a particular time. It is not concerned with characteristics of individuals as individuals but is concerned with the generalized statistics that result when data are abstracted from a number of individual cases. It is usually cross sectional.

The survey is an important type of research; it must not be confused with the more clerical routine of gathering and tabulating figures. It should involve a clearly defined problem and definite objectives. It requires expert and imaginative planning, careful analysis and interpretation of the data gathered, and a summary of the findings.

Evaluation

In evaluating public-opinion surveys, several sources of error may be recognized. The problem of accurate sampling is important; improper sampling would result in poor data and inaccurate results. The energy field is so rapidly evolving that it is very difficult to determine the number of recipients or who should be included in the sample for the best results of the survey.

The shifting routine of public sentiment is a possible source of error. With the rapid changes occurring in the energy field, public ideas and concerns are changing with each new crisis.

In addition to the limitations suggested, there is the problem of careless responses given without due consideration that could affect your results.

The Questionnaire

I will refer to the survey instrument as the questionnaire which is designed to obtain data from the recipient in written form. When this device is administered by mail, it is referred to as a questionnaire.

The questionnaire is one of the most popular data-gathering devices. The preparation of a good questionnaire takes much time, ingenuity, and hard work.

The completion of lengthy questionnaires takes time and effort—a favor that few senders have any right to expect of strangers. An unfavorable reaction is increased when the questionnaire is long, the subject trivial in importance, the items vaguely worded, and the form poorly organized. Perhaps the unfavorable characteristics of many questionnaires explains why the response to questionnaires sent out by mail is often small. The information in the unreturned surveys could possibly have changed the results of your research.

In doing energy related surveys, one will normally be dealing with a group of respondents who are interested in the energy problem and a good response should be expected. Plans for personal follow up on unreturned questionnaires will result in a higher response rate and more complete information.

There are two types of questionnaires (1) the closed form and (2) the open form. Questionnaires that call for short, check responses are known as the restricted or closed-form type. They provide for marking a "yes" or "no", a short response, or checking an item from a list of suggested responses. Even with the closed form, it is important to provide for an anticipated response. Providing an "other" category permits the respondent to indicate what might be his most important reason. The closed form is entirely satisfactory for energy related surveys in that it is easy to fill out, takes little time, keeps the respondent on the subject, is relatively objective, and is farily easy to tabulate and analyze.

The "open form" or unrestricted type of questionnaire calls for a free response. This form provides for greater depth of response; however, it is sometimes difficult to interpret, tabulate, and summarize.

A major pitfall in the development of a questionnaire is often the fact that the researcher does not know exactly what he wants to find out. This frequently results in asking the wrong questions, not phrasing them properly, or difficulty in wording the questionnaire clearly. The limitation of words are particular hazards in the questionnaire. The same words mean different things to different people. The researcher has his interpretations and the respondent may have many different interpretations. In an interview situation, one is able to clear up the misunderstanding but the written question stands by itself, often ambiguous and misunderstood. It is apparent that one cannot be too careful in phrasing questions to insure this clarity of purpose. There is no way to produce a foolproof questionnaire, but here are some suggestions that should help make your questions more precise:

1) Define or qualify terms that could easily be misinterpreted. There are hundreds of words that are ambiguous because of multiple definitions. Also, new terms or words should be defined.
2) Avoid unwarranted assumptions.
3) Avoid the double-barreled question. If two answers are required, be sure the two questions are asked separately.
4) Beware of double negatives. Questions using double negatives are confusing.
5) Make sure your answers offer adequate alternatives.
6) Be careful in using descriptive adjectives and adverbs that have no agreed-upon meaning. This fault is often found in rating scales as well as in the questionnaire itself.
7) When asking for ratings or comparisons, a point of reference is necessary.

8) Phrase your questions so that they are appropriate for all respondents.
9) Design questions that will give a complete response.
10) Consider letting the respondent classify the responses by answering questions rather than choosing categories.

These are only suggestions to improve the clarity of your questions. There is no simple set of rules for one to follow. The task is a difficult job—one that requires a great deal of hard work, imagination, and ingenuity.

In developing an energy survey, one should be aware of the characteristics of a good questionnaire.

1) It deals with a significant topic. Energy is a topic the respondent will recognize as important enough to warrant spending his time to complete. The significance should be clearly and carefully stated on the questionnaire or in the letter that accompanies it.
2) It seeks information which cannot be obtained from other sources.
3) It is as short as possible, easy to read, and easy to complete with minimum effort. Long and complicated questionnaires are easy to lay aside.
4) It is attractive in appearance, neatly arranged, and clearly duplicated, or printed.
5) Directions are clear and complete, important terms are defined, each question deals with a specific idea, all questions are worded as simply and as clearly as possible, and the categories provide an opportunity for easy, accurate and unambiguous responses.
6) The questions are objective with no leading suggestions as to responses desired.
7) Questions are presented in good logical order proceeding from general to more specific responses. This helps the respondent to organize his own thinking so that his answers are logical and objective.
8) It is easy to tabulate and interpret. It is often helpful to anticipate how the data will be tabulated and interpreted before the final form of the question is decided upon.
9) Proper code numbers are established if the survey is to be mechanically tabulated.

In preparing and administering the questionnaire, get all the help you can in planning and developing the instrument. Utilize other questionnaires and information that might be available.

Try out your questionnaire on a few friends or acquaintances. This will assist you in finding any ambiguous questions and will also indicate the time required to complete the survey. This "dry-run" will be well worth the time and effort that it takes in that it will reveal defects that can be corrected before the final form is printed and mailed.

Choose respondents carefully. It is important that questionnaires be sent only to those who possess the desired information, and those who are interested enough to respond conscientiously and objectively. It is suggested that the questionnaire be sent to the administrative head of the organization rather than directly to the person who has the desired information. There seems to be an implied obligation when the questionnaire is passed down from a superior officer.

There are occasions, for purposes of classifications, when the identity of the respondent is necessary. If a signature is needed, be sure to convince the respondent that his responses will be held in strict confidence.

It is advisable to try to get the aid of sponsorship. Recipients are more likely to answer if a person, organization, or institution of prestige has endorsed the project. At Pitt Community College, we were able to get the endorsement of the Governor.

The cover letter is a very important aspect of any questionnaire. It should be courteous, carefully constructed to explain the purpose of the study. The letter should promise some sort of inducement to the respondent for his willingness to comply with your request. A summary of the questionnaire results is considered an appropriate reward.

The cover letter should assure the respondent that delicate information will be held in confidence. The explanation of sponsorship might well be mentioned. It is very important to enclose a prepaid addressed return envelope. To omit this courtesy will result in a poor return rate.

Recipients are often slow to return completed questionnaires. To increase the number of returns, an active follow up might be appropriate. A courteous postcard reminding the recipient that the completed questionnaire has not been received will bring additional responses. This reminder will be effective with those who have put off or forgotten to return the questionnaire. A further step would be personal letter or phone call.

SUMMARY

The same basic rules and common sense will apply to the research involving energy questions. Many pitfalls can be avoided if one is willing to apply these suggestions given. A benefit to the researcher involved in doing an energy survey is in the fact there is tremendous interest and enthusiasm on the part of the public in respect to doing something to help with the energy situation. Public awareness of the energy problems should enhance your effort to solicit information from your respondents.

A Model Needs Assessment

Michael J. Nastick, Employment and Training Administration, U.S. Department of Labor, Denver, Colorado

BACKGROUND

The 1973 Arab oil embargo and its aftermath focused the attention of the United States on the Rocky Mountain Region. While gas lines grew and prices rose the concern over our energy producing capability extended to all forms of energy resources. Federal Region VIII, made up of the States of Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming suddenly became more than just an area West of the Mississippi and East of California. An area containing roughly one-third of the Nation's land mass but less than one-tenth of its population was transformed into a potential wonderland of problem solving energy resources.

A few statistics will place the attention focus in perspective. These six States represent the fastest growing energy producing region in the Nation. Consider, if you will, that 50% of our country's coal reserves are located in Region VIII. In this region coal production in 1978 exceeded 120 million tons, up from 55 million tons in 1974. Projections are that production will reach 350 million tons per year by 1985 and over 500 million tons by 1987. The increase in coal mining is accompanied by accelerated construction of coal fired power plants. Power plant capacity is expected to double in the next five years with about half of the electricity produced transmitted to load centers in the Midwest, Southwest, West Coast, and Northwest.

Coal is but one energy resource. Oil shale deposits in the region comprise more than 90% of the Nation's reserve and are concentrated in a relatively small area of Western Colorado, Northwestern Utah, and Southwestern Wyoming. Recoverable reserves are estimated at 600 billion barrels compared to a national consumption rate of just over 6 billion barrels of oil in 1978. This resource alone provides enough energy to run the country for perhaps 100 years based on recent consumption.

About 93% of the uranium reserves are located in this area and in contiguous States. Wyoming, Colorado and Utah have vast uranium ore deposits. Current estimates forecast that production will almost triple by 1985. If we develop a heavy reliance on nuclear energy greatly expanded development will occur.

The region contains extensive geothermal resources, hydroelectric, gas and oil reserves. The Solar Energy Research Institute is located in Colorado.

All of these potential resources together establish Region VIII as the energy breadbasket of the Nation. The implications of such a designation almost defy understanding. The "boom town syndrome" exemplified by experience in Rock Springs and Gillette, Wyoming leap immediately to mind. Visions of slag heaps and other unattractive perceptions of energy development easily replace the area's scenic beauty in the minds of westerners. The potential for both benefit and disaster as a result of energy development is mind boggling. When one considers the environmental issues involved, the social and economic impact, and just the enormity of the undertaking, it is no wonder that the Western Governors Conference and the general populace react nervously to the issue.

Conservative employment projections show that through 1983, approximately 30,000 new energy jobs and 34,000 new secondary jobs will be created by energy industry expansion in the six States of Region VIII alone. As an example the city of Denver already has over 2,000 energy companies located within its boundaries. The region wide unemployment rate is currently 4.1%, up slightly over recent months. Given this rate and the scarcity of population, particularly in the areas where resources exist, immigration coupled with training programs for the current inhabitants become major issues. The myriad of other issues such as mineral taxes, road and town construction, environmental concerns, the quality of life, economies of scale, etc., are all elements of the energy dilemma. This paper and the model needs assessment it describes deals with only one of those many issues—as the motto of the State Job Service Agencies puts it—jobs for people and people for jobs.

The Department of Labor, Employment and Training Administration (DOL-ETA) and in particular the Region VIII Administrators began to focus on the problem in 1975. The energy resources available in the region had been spotlighted. The need for current and projected labor market information became very clear and the development of a capability to assess the employment impact of extensive western energy resource development became an acute necessity. We felt that through an energy employment assessment initiative, information and knowledge could be developed to not only give direction and guidance to Department of Labor future strategies but would also be of some assistance to States and to units of local government, as well as to the private sector.

Region VIII DOL-ETA subsequently contracted with the Bureau of Business and Economic Research of the University of Utah and the Utah Employment Security Bureau to help us get the job done. Over the past four years we have instituted and carried out a number of research projects designed to add to the body of knowledge available and to build some basic understanding of occupation changes resulting from energy development. Most of the material contained in this paper has been extracted from the various studies and papers prepared by University of Utah economists and researchers under contract with the Department of Labor.

The first effort was a paper entitled *Energy Employment: The Critical Dependency in the U. S. Economy,* authored by Mr. Robert J. Brown then DOL-ETA Regional Administrator and later Under Secretary of Labor, Mr. Willis J. Nordlund and Ms. Kathy Workman, University of Utah economists. Its purpose was to examine the nature of the problem and to devise ways to begin to deal with it. A supporting paper entitled *Methodology for Projecting Employment Requirements for Energy Development and Expansion in Federal Region VIII* calculated employment projections for coal mining, power plant facilities, and coal conversion facilities. These were some of the first such projections developed in the region and generated great interest on the part of manpower planners, the private sector, and economists throughout the region. It also served as the basis for the needs assessment tool this paper is concerned with, the development of an energy model which produces employment projections by industry and especially by *occupation*.

Using the University of Utah computer the model provides the basis for the assessment of total employment impacts resulting from energy development. It is not the purpose of this paper to fully describe all technical aspects of the model. Such data are available upon request. Rather, some brief remarks will serve to outline the conceptual basis.

Description of the Model

For calibration purposes the model makes use of county specific historical data on wages and salaries, earnings and employment from the Regional Economic Information System file of the U. S. Department of Commerce, Bureau of Economic

Analysis (BEA), and region specific industry-occupation matrices developed within the framework of the National/State Industry-Occupation Matrix System, conceived by the U. S. Department of Labor, Bureau of Labor Statistics (BLS). The BEA income and employment data are at the 2-digit Standard Industrial Classification level of detail, while the National/State Industry-Occupation matrices have some 200 industrial categories and 400 occupational categories.

The industrial dimension of forecasts produced by the Labor Demand Model is mainly determined by the detail of the industrial classification system used by the BEA. In order to achieve matrix compatibility between the BEA system and the BLS system, it has been necessary to convert the regional industry-occupation matrices from the census industrial classification system to the Standard Industrial Classification System used by the BEA. This has been accomplished by means of a conversion algorithm that takes into account not only differences in industrial classifications, but also differences in class of worker.

Aggregating the Industry-Occupation Matrix System data to the BEA income and employment data level of industrial detail results in approximately 70 matching industrial categories which constitute the elemental industrial sectors of the Labor Demand Model. On the basis of supplementary occupational requirements information, certain of the energy producing and construction sectors have been disaggregated, so that the model is capable of producing forecasts of employment change for approximately 80 industrial sectors and 400 occupational classifications.

Energy Development Inputs

The model focuses on the Labor Market Area concept. Labor Market Areas are defined as one or more counties in which there is a concentration of economic activity or labor demand and in which workers can readily change jobs without changing their place of residence.

The basic inputs to the model consist of projected changes in employment in basic energy producing industries. For purposes of the initial run of the model, basic energy producing industries were defined as:

- Coal mining
- Coal-fired power plant construction and operation
- Coal gasification construction and operation
- Uranium mining and milling

- Oil shale construction and operation

This is not an inclusive list of energy producing industries in Region VIII states; these industries were chosen for the first run because of the accessibility of development data. Future plans call for collaboration with model users to expand and refine the energy development input file for use in future runs of the model.

It should be noted that the model has been developed so that projected changes in employment in other basic industries can also be used as inputs. The model could be used to produce occupational projections for all types of industrial expansion.

Methodology

As was mentioned above, model inputs consist of changes in employment by year for the specified energy producing industries.

A variety of sources were used to track planned and proposed energy projects in Region VIII states. Sources include:

- *Western Coal Development Monitoring Systems, Quarterly Reports,* U. S. Department of Energy
- *Projects to Expand Energy Sources in the Western States*—An Update of Information Circular 8719. Bureau of Mines Circular 11987, IC8772
- U. S. Department of Labor, Construction Manpower Demand Model
- *West-Central North Dakota Regional Environmental Impact Study*. Draft. January 1978, State of North Dakota, U. S. Dept. of Interior
- The Sixth District Council of Local Governments, Rapid City, South Dakota
- *Coal Age Magazine,* New Coal Mine Development and Expansion Survey
- Contact with state and federal agencies
- Contact with energy firms
- Press releases and newspaper articles from the six states.

Energy developments were identified by industry type, location, size, length of construction period and employment requirements (if available). In cases where employment requirements were not available for the project, requirements were extrapolated using standardized industry staffing patterns (manning tables). Once employment levels by year by county were compiled, they were compared to the 1977 actual employment benchmark data by county by industry to ascertain the changes in employment by year.

In terms of geographical areas, selected groups of counties in Region VIII's six states were established as energy impacted labor market areas. The delineation of substate areas was based on the established planning regions used for Region VIII employment and training planning purposes. In future runs of the model, it may be necessary to select different geographical configurations such as interstate areas, for example Big Horn Co., Montana and Sheridan Co., Wyoming which more accurately reflect "labor market areas".

Current Status

A computer-based project file and data entry system for the model is now operational. Completion of this phase of the project represents a major accomplishment insofar as information retrieval and reduction in turnaround time is concerned. The project file and data entry system is an interactive project file catalog system that allows for the expeditious updating of energy project information from a remote terminal. Runs of the Labor Demand Model may now be made directly from the data in the system without the necessity of any intervening manual data entry. In addition, the system may be accessed at any time from a remote terminal to obtain information regarding individual energy projects within Region VIII or to obtain summary data by industrial sector for counties, labor market areas, states or for the entire region.

The model outputs currently being produced cover 17 labor market areas encompassing 97 counties in the six states of Region VIII. The outputs represent industrial and occupational levels and changes by year through 1983 for each of 17 areas. More specifically, for a selected labor market area, say planning District 11 in the State of Colorado—an area covering 4 counties where energy development is a reality and expansion is a certainty, the model output will show current employment by occupation and by industry, and project employment needs the same way, year by year, through 1983. If, for example, current employment of craft and kindred workers in construction industries is 2,368 and projections show a need for 3,511 in 1983, then training needs and/or an in-migration possibility immediately come to mind. Either way this one specific occupational need, together with needs for all occupations, present a planning base not only for employment opportunity but for all the other social and economic aspects of an area's anticipated development and growth.

Occupational projections have been available from the Labor

Demand Model for approximately one year. During this time energy project staff personnel have worked extensively with Region VIII State Employment Security Agencies (SESA's) and Comprehensive Employment and Training Act (CETA) prime sponsors, providing information on the model and assistance with the analysis and use of occupational projections. Special assistance has been given to the Wyoming and Colorado balance-of-state prime sponsors and to the Colorado Office of Manpower Planning and Development in analyzing the projections for use in substantiating the need in developing special energy related programs.

Basic model documentation has been provided in the form of a manual for model users. This manual provides (1) a technical description of the model, (2) a discussion and specification of the energy project scenarios that have been employed in running the model, (3) a discussion of the assumptions and limitations of the model, and (4) a discussion of further refinements and uses to be made of the model.

Assumptions and Limitations of the Model

An underlying premise in economic base (multiplier) type models is that the existence and growth of a region depends upon the goods and services it produces locally and sells as exports outside its boundaries. These export receipts provide for the means of payment for the region's own imports and for the supportive goods and services it buys locally. A critical distinction in the composition of basic (primary) industry sectors versus the residentiary (non-basic or service) sectors is made. Basic-to-residentiary multipliers are derived through the use of historical data on employment and/or income, and through the introduction of appropriate values for projected expansion in the basic sector, estimates for the secondary components can be derived. Apart from conceptual issues such as qualitative changes in technological and socioeconomic conditions which cannot be adequately quantified, technical limitations in the use of economic base models lie in the suitability and availability of the data base, the delineation of basic versus residentiary sectors and the selection of the appropriate geographical regions for analysis.

- *Availability and Suitability of Data*

  Employment data, though more easily available than income data at the county level, do not adequately reflect the magnitude and character of an area's economic system. For instance, employment data cannot shed light on the different potentials for expansion brought about by different wage levels in different industrial sectors, different ratios of part-time versus full-time jobs, and different proportions of unearned versus earned incomes. The Region VIII model uses income as the primary measure of economic activity. It acquires county specific historical data on wages and salaries, earnings and employment from the Bureau of Economic Analysis file, which is quite comprehensive and has a historically consistent data series. However, the data are not generally available until about 18 to 24 months after the end of the year of reference. Ideally, State Employment Security data from the ES-202 reports should be able to partially bridge the gap, at least on current employment statistics, since these reports feed into the BEA files and are available much before the BEA release data but potential for significant error remains.

- *Delineation of Basic versus Residentiary Sectors*
Another technical problem applicable to all "multiplier" type models is that of identifying basic versus residentiary components. One method is to use some form of a location quotient or "concentration" ratio to identify industries which are basic. Ratios greater than unity indicate the extent to which total employment or wages is basic. Another method is to take a firm-by-firm approach and, based on empirical information on the location of each firm's market, proportions as to how much of the firm is basic versus residentiary are determined.

The Region VIII model, in its initial runs, has used an a priori classification system to delineate industries which are wholly basic, those which are wholly residentiary and those which are mixed. Of 76 industrial sectors, 35 were deemed essentially residentiary, 33 basic or export, and 8 "mixed".

Clearly, the differences in the method of identifying basic versus residentiary components can cause significant variations in the computation of the multipliers. The initial runs of the Region VIII model treated the some 270 non-SMSA counties of Region VIII as a group and used the same basic and residentiary components and average multiplier values in each of the counties. A revised formulation of the model will involve the use of empirical data and expert knowledge to classify areas into one of several classes of basic versus service mixes.

- *Selection of Geographic Region*
Another issue deals with the delineation of the geographic

area for which the model is run. In a pragmatic sense, the areas chosen have always been areas targeted because of programmatic implications and for which planning data are required. However, such areas' boundaries do not necessarily conform to the ideal Labor Market Area and, to the extent that commuting and consumption activities are not essentially confined within such areas, the problems arise in the assignation of total impact to the area.

It is apparent from the initial runs for the Region VIII model that in some instances, an area different than the planning district should have been delineated. In at least one instance, an interstate Labor Market Area may have been more appropriate. It should be noted that the resulting numerical values of the various multipliers may be significantly changed by the base area chosen. Also, because of the procedures involved, the outputs for a run made on an aggregate area may not equal the sum of the outputs made independently for the smaller areas comprising the total.

Model Refinements and Project Emphasis

During FY 1980, improvements in the precision and accuracy of the Region VIII model are being planned. These include the following elements:

Technical

- Complete inclusion of the dynamic lag formulation. A capability for predicting the actual time path of development in terms of year-to-year sequential multiplier effects is expected to be fully in place.
- Calibration for metropolitan Labor Market Areas. Up to the present, the model has been calibrated only with data based on the some 270 non-SMSA counties in Federal Region VIII since energy developments have primarily occurred in non-SMSA counties. Since the dynamics of interaction between the basic and service sectors in non-SMSA counties are expected to be different from SMSA counties, calibration of the model to SMSA counties is also being planned.
- Incorporation of occupational detail from energy-specific projects and from the Occupational Employment Survey (OES) Program.

The special attention to energy occupations entails the incorporation into the Industry-Occupation matrices of more precise and current occupational profiles for certain energy activities. Occupational profiles for coal mining, uranium mining and milling, oil shale conversion and coal gasification will be compiled and introduced into the I/O Matrix.

To further strengthen the occupational estimating component of the Labor Demand Model, an innovative use of occupational survey data from the Occupational Employment Survey (OES) Program is being examined for possible incorporation into the model. The OES program is primarily designed to produce survey-based occupational information for state-wide and major SMSAs. Using a simulation approach, the Utah Employment Security Agency has devised a methodology to produce industry-occupation matrices specific to local labor market areas. This approach uses the OES occupational classification system, which, more so than the census-BLS classification systems, identifies training and task attributes for each of over 1,200 occupations. Outputs from this project have been produced with simulation having been run for Utah and Colorado areas. Further testing and evaluation are being conducted with results to be available in April 1980.

A Generalized Use of the Model for Impacts of Non-Energy Developments.

The basic formulation of the Region VIII Labor Demand Model is such that its use is not limited to the energy area. The model could be used to produce industry and occupation employment impacts for any change in basic sector activity. A general application of the model in this manner is expected to augment the Labor Market Information program conducted by the Employment and Training Administration through the State Employment Security Agencies.

CONCLUSION

The Region VIII model, as well as any other model, should not be used blindly. The Region VIII model can give no more than approximate values and only for the direct and indirect effects of specified input data. The user is also urged to examine the input assumptions used and to supplement the model output with other available information. It is too early to make hard judgments on its accuracy and reliability. To date it has been useful as a planning tool. The true test of its effectiveness must await the intensive and rapid energy development anticipated for the Rocky Mountain Region.

Renewable Energy and Employment: Decentralized Energy and Jobs in the 80's

Scott Sklar, The National Center for Appropriate Technology, Washington, DC

> *"Economic development is primarily a question of getting more work done. For this, there are four essential conditions. First, there must be motivation; second, there must be some know-how; third, there must be some capital; and fourth, there must be an outlet; additional output requires additional markets."*
>
> *E.F. Schumacher*

> *"Man invents a machine and he controls it; then the machines begin to control him and he becomes the slave of his slave"*
>
> *Kahlil Gibran*

FINITE RESOURCES: WHY RENEWABLE ENERGY?

> Overall population in the United States is expected to increase by 22% by the end of the 20th century. Oil production will continue to decline steadily through the rest of the century while gas production should decline much more sharply. Electrical power consumption is expected to increase steadily for the rest of this century. Coal and water used in energy production will rise sharply after 1985 and thereafter through the rest of the century. Can the United States build *the number of* nuclear and coal burning plants in the face of environmental, safety, and resource problems?

The above scenario comes from a Department of Commerce Report regarding U.S. energy consumption and production by the year 2000. The thrust of the report is that there is no free ride. For every step forward there is a drawback. The average citizen seems confused by the sheer mass of information and the contradictory data thrown out by every interest group throughout the country. Which information is correct? Where do we turn? On what basis do we measure what is right? These are hard questions that both policymakers and scientists have been grappling with for some time.

But even in the fact of a hodgepodge of energy facts and figures, there are some self-evident truths on which almost everyone agrees:

- Oil and natural gas do have limits and will be depleted in the future.
- Coal, although plentiful, will place great demands on resources in both inputs (mining) and outputs (pollution).
- Public confidence in nuclear power is at an all-time low, largely because of concerns about safety.
- Energy prices will continue to rise as a result of short supplies of conventional fuels and the large amounts of capital needed to develop new energy technologies.

So, the crucial question becomes which energy technology or technologies do we choose? Many proponents of an *assertive* energy policy have turned to solar energy in its broadest context: passive and active solar, wind, hydroelectric power, biomass (alcohol, methane, wood) as one of the answers. In its 1979 *Blueprint for a Solar America*, Solar Lobby contends that biomass energy will contribute 25% of the nation's energy by the year 2000, a growth rate of 722% in 25 years. More rapid transitions *have* occurred in American economics. Between 1940 and 1962, oil and gas captured an additional 30% of the energy market, largely because government subsidies and price controls made these fuels economically attractive.

Many solar advocates assert that it is unnecessary and unwise to finance energy technologies that are risky or employ finite resources (nuclear and coal, respectively) because it is inevitable that the U.S. must turn eventually to renewable energy technologies. Therefore, maximized immediate development of solar technologies, although expensive in the short-term, would save untold billions in the future change-over. Many other arguments, besides economics, have been used to promote renewable energy technologies; these include environmental aspects and, most importantly, the security and employment benefits of a renewable-energy future.

This paper briefly analyzes the tremendous employment potential and advantages of scale that renewable energy technologies offer, and will discuss the need for training the labor force so that the United States might successfully face its most important challenge in history.

The Soft Path in a Nutshell

Aside from E. F. Schumacher and Amory Lovins, the most publicized advocates of appropriate technology, others have also supported the decentralized small-scale approach to technological and business development. This approach ranges from farmers rallying to produce alcohol fuel from farm surpluses to incidents of violence against large power lines through their farmland. The Defense establishment has issued several warnings regarding the vulnerability of the sea lanes as well as domestic facilities for oil production, refining and transportation, and nuclear power plant security vis-a-vis terrorists.

Whichever concern you heed, "technology with a human face" via Schumacher of "national security" via the National Security Agency, the questions of scale and decentralization are important ones. The questions become intensified when projected to some real world problems faced by other centralized industries today. The Senate Government Affairs Committee has held several hearings on the effects of "boom-towns" threatened by rapid synthetic-fuels development. The aerospace and automobile industries, among others, reel with the ebb and flow of policy decisions that cause havoc with their workers. Clearly, short-term defense projects employing thousands in an area, then closing and fostering heavy unemployment, displacement and personal trauma are experiences with which American workers are all too familiar. What are the alternatives, and how do we assure security and mass employment opportunities in a future scenario of energy development?

Renewable Energy and Employment

In respect to renewable energy job opportunities it is important to recognize that conservation is an important first step in the transition. Why produce energy just to have it pass through the structure like a sieve? Therefore, no matter what technology we opt for, the more efficient use of each Btu of energy produced is a mandatory requirement. Jobs related to any energy transition will incorporate high employment benefits. For instance, in the Grossman-Daneker[1] study they analyze the onsite labor potential versus new power plant construction, quoting a Bonneville Power Administration study:

> High Impact conservation programs create more jobs than would be created by building new power plants to generate an equivalent amount of energy.

These benefits are best illustrated in the Buchsbaum-Benson[2] study below which was based on a 38 year model of a conservation solarization project in New York. The net job potential is:

Insulation workers	17,928
Home Improvement workers	36,826

Sheetmetal workers	3,050
Plumbers	5,635
HVAC workers	12,081

Based on investment of $2,200 per house, 34 conservation measures equalling a 43% reduction in oil and electricity, 1976 dollars. Over 38 years, average of 5,200 jobs, Nassau-Suffolk counties, N.Y.S. The key issue however, is not just the number of jobs per project but the overall effect on the economy. First, a $4.4-billion energy-conservation scenario, as studied in this report, would have a multiplier effect of 2.40—for every dollar spent on energy conservation and solar related expenditures, an additional $1.40 worth of economic activity (output) would be stimulated in the national economy. Such a conservation program would have a total of 48 *years* direct economic life.

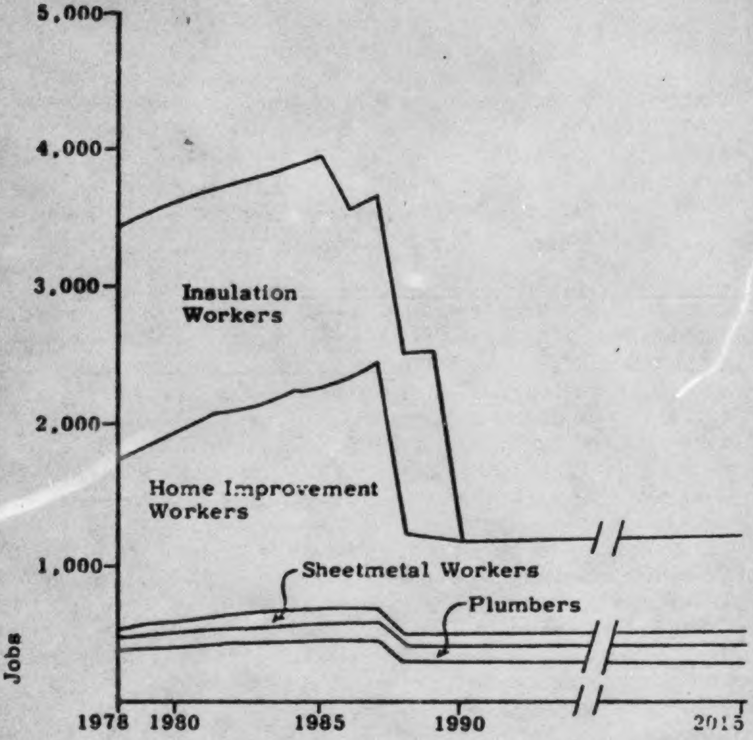

Figure 1: Conservation Scenario On-Site Employment

Perhaps the most significant real possibilities occur in combining the solar option with conservation. In part, the aforementioned figures do this in the Council on Economic Priorities Study. However, pulling out the solar option alone, the following data come to light. Installation of the two CEO measures which included 100,000 solar hot-water heaters and incorporation of passive design or passive solar retrofit totalling $270 million, energy savings would be $1.07 billion during the next 40 years and 200-400 steady jobs would be created in the area; along with the earlier conservation multiplier and employment opportunities.

The *Energy, Jobs and the Economy* study states:

> If energy quality is matched to its ultimate use, each of these renewable energy systems (other than photovoltaics) has lower capital requirements per unit of energy delivered to the user than does nuclear fission and production of synthetic fuels from coal.

The study further maintains that if half the Massachusetts buildings were converted to solar for water heating, 32,000 jobs would be created, 600 million gallons of oil would be saved, and $480 million would be retained in the state.

In *Jobs from the Sun*, the California Public Policy Center estimates that over 100,000 jobs would be created from a solar installation program in California alone during the 1980's. The real issue addressed by the import of fuel is inflation which erodes buying power and world commodity stability. Clearly, to keep dollars at home will have a multiplier effect in terms of employment within our borders. Fuller's basic treatise is that shortages of supply from a resource base will contribute to an inflationary trend. Therefore, any way to expand that energy resource base will have a positive effect. If the base can be expanded through *long-term* energy projects, such impacts will have profound effects on the U.S. and throughout the world.

In conclusion, a decentralized energy technology would improve security, control and humanization of society and steer the nation toward efficient conservation and domestic renewable energy production. Thus, employment, quality of life and inflation issues would be positively dealt with as part of a single, sweeping "energy Policy that would have broad impacts."

The key question is whether we have the capability to use our *human* resources to solve the energy problem, and that's where the educators in this audience should concentrate. The fact is that we need a trained work force that shares the fundamental goals of "can-doism", self-sufficiency and energy as a basic right of all humans. These three premises are not easy, and cannot be taken lightly; but they are the basis for American survival and world survival. We should not forget that we are only 3% of the world's population, yet we consume more than 35% of the world's finite resources. Clearly we have an obligation to ourselves and our partners in the world community to use our national strengths and resources in the most positive way we can.

THE FUTURE GOAL?

As Roy Meader describes in his book, *Future Energy Alternatives*, as the best long-term goal is one in which we might imagine this conversation:

> "Mr. President, Mr. President, we just ran out of oil!"
> "Fine, flip the switch and turn the sun on."

REFERENCES

1. Grossman, Richard, and Gail Daneker, *Energy, Jobs and the Economy*, Alyson Publications, 1979.
2. Buchsbaum, Steven, and James W. Benson, *Jobs and Energy*, Council on Economic Priorities, 1979.
3. Worldwatch Papers (21 & 34), *Soft Technologies/Inflation*, Colin Norman and Robert Fuller, 1978, 1980 respectively.

A Profile of Energy Education Programs

Jack Seum, National Field Research Center, Inc.,
Washington, DC

INTRODUCTION

In late 1975, Congress acknowledged the growing national concern for the preservation and conservation of our national resources with a direct inquiry into the availability and readiness of our environmental workforce. That inquiry took the form of a three-year, three-phase *National Environmental/Energy Workforce Assessment,* conducted by National Field Research Center under the direction of the U.S. Environmental Protection Agency. In keeping with the objective of the assessment, this three-phase national effort directed itself at environmental/energy workforce needs, national educational preparedness, and the functional relationship between the two.

Phase I of the *National Environmental/Energy Workforce Assessment* focused upon the development of "workforce demand projections" through 1982 for all public environmental agencies. This on-site assessment, which was carried out in all 50 states, Puerto Rico and the Virgin Islands, culminated in a numerical profile of the growth patterns and workforce needs at the national and state levels. Stratification of the overall definition of "environmental occupations" into seven distinct vocational areas enhanced even further the applicability of results. In addition to this public sector workforce assessment, Phase I included an overview analysis of private sector needs (through an adjunct mail survey of selected businesses and industries) and a brief review of selected environmental programs. Phase I was completed in May, 1977.

Phase II was structured around an intensive on-site inventory of representative environmental educational offerings on a national scale. The primary objective of this project was to collect and aggregate data on training and educational programs in both the post-secondary education field and in the private sector and to do so by environmental area. Specifically, the study was designed to provide an overview of environmentally related post-secondary education programs, their program structure, representative course offerings, employment history of the graduates, and the faculty structure. Additionally, information was collected on program requirements and program projections.

The third phase was directed toward the assimilation of information gathered during both Phase I and Phase II. Materials from the previous phases were analyzed and synthesized. Based on these analyses, four issue papers, or monographs, were developed for the purpose of discussing aspects of the NE/EWA findings in greater depth than previously allowed. The four monographs developed were:

- Salaries and Attendant Problems of Public Sector Environmental Employment
- The Role of CETA in Direct Training and Employment
- Private Sector Training
- Problems in Environmental Education and Training

In addition to the four monographs, a report of the issues related to the use of Title VI CETA in carrying out environmental pollution control and abatement activities was developed.

A third priority was to develop, by medium, a listing of all post-secondary institutions offering environmental and energy programs. All catalogs reviewed during Phases I and II were replaced with up-to-date ones (where possible), and all were examined once more. This information was compiled into a listing made by program area of schools offering environmental and energy programs of study.

Finally, Phase III researchers developed an annotated bibliography of material of potential value to environmental workforce planners.

Since energy education was one of several program areas covered in the course of this study, I will focus only on that particular part of the entire effort. Phases II and III of the workforce assessment each contained a volume devoted solely to energy programs and Phase II covered this area in greater depth. Most of the remaining presentation will address the Phase II results.

Need for a Comprehensive Policy

Interviews conducted during Phase I of the National Environmental/Energy Workforce Assessment revealed a growing awareness of the need for a comprehensive energy policy at all governmental levels. Coupled with that heightened awareness was the expression of concern that persons presently in positions requiring energy related decision making were ill-prepared to do so. Such comments were often followed by remarks concerning a rising need for persons trained in energy/management skills. The concurrent need for a larger, better-trained workforce at all levels of energy activities was seldom slighted by respondents. Many also voiced concern that headway in pollution reduction might be lost as energy matters increase in priority. People often added that increasing the proportion of the energy research funding allotted to alternative sources is essential to obtaining sufficient energy for a dynamic society in an environmentally sound manner.

The programs included in Phase II are evidence that people are doing more than just talking about our energy future. In addition to well-established programs in nuclear engineering, mining, petroleum and natural gas technology and engineering; there were programs such as Cornell's College Program in Energy Conversion, the interdepartmental Energy Engineering and Policy program at the Polytechnic Institute of New York, the Energy Conversion and Resources Topical Program at Princeton, the undergraduate Energy Resources Management program of Lamar University, the University of Pennsylvania Energy Management and Policy multidisciplinary program, and several others which represented innovative approaches to a broad spectrum of energy problems.

Each of the programs surveyed in energy was described individually in the Phase II report. The selected course offerings included in each program summary were indicative of the range and depth of energy education. The summaries included program descriptions which detailed program structure and requirements; a faculty, student, and graduate profile; and a program projection commentary.

Data for Phase II were gathered through on-site visits and follow-up correspondence with faculty and staff of colleges, universities and training institutions in forty-five states. Energy education programs offered by more than thirty schools in eighteen states were surveyed.

The report included detailed information regarding more than forty energy programs in which ninety-five certificates or degree sequences were offered. Selection of these programs was based on a variety of factors including: information and recommendations obtained during Phase I of the project; recommendations by state, regional, and federal environmental/energy agency personnel; a review of course catalogs; and a review of other published sources of information reagarding degree programs in environmental/energy areas.

On-site visits and extensive interviews were conducted to explore each of these programs in depth. Many of the institutions visited offered programs in several environmental areas as well.

Diverse Nature of Programs

Because of the extremely diverse nature of the energy educational programs surveyed, there were few characteristics held in common throughout. Enrollments varied from fewer than ten to more than six hundred. Nearly 60% of the students were in bachelors programs; of these, 99.5% were full-time students. Associate degree programs accounted for slightly more than 25% of all students; nearly three-quarters of these students were full-time. Part-time students in these programs often held full-time jobs, especially in mining technology programs. Approximately 13% of the students were enrolled in masters programs; of these only two-thirds were full-time. It is at this level that many students were employed full-time and had returned to school to enhance their opportunities for advancement or to qualify for a job significantly different from that presently held. Doctor of Philosophy and Doctor of Science degree candidates accounted for little more than 3% of the enrollments; nearly 90% were enrolled fulltime. Of those who were listed as part-time, most had completed all course work and were working on dissertations; many of these were employed full-time. Fewer than five percent of the students in the energy education programs surveyed were women.

Of special significance was the overall enrollment trend. Higher education, as a whole, was experiencing a time of steady or declining enrollment. The energy field was more than holding its own. Four of the five mining technology associate degree programs reported increasing enrollments; one had declined. Half of the B.S. programs reported stable enrollments; half reported increases. Twenty masters programs had increased enrollments; 12 were stable; 3 did not reply to this question. Eight doctoral programs noted an increase in enrollment; ten were stable.

Overall, approximately 88% of the students were full time; 12% part-time. More than half of the part-time students (nearly 60%) were at the associate level; many were miners. More than a third of the part-time students were masters degree candidates. B.S. and Ph.D. students accounted for less than one percent of the part-time enrollment. With only one program (at the associate level) indicating a decline in enrollment and the remainder nearly equally divided between stable and increasing enrollments, as a whole, energy education enrollments were increasing.

The ratio of in-state to out-of-state and foreign student enrollment varied greatly. Among the associate degree programs, 80 to 100% of the students were in-state; none were foreign. Among the bachelors programs, one reported 98% in-state enrollment, one only 33% in-state; most ranged from 70–80%. Four schools noted foreign enrollment ranging from 5% to 30%. Masters enrollments varied from a high of 75% in-state to a low of 20%. Most reported 50% or less. About half had foreign students, varying from 5% to 50%. Ph.D. enrollment ratios were similar to the masters. Several schools indicated that foreign applications to their programs were extremely heavy.

Of the graduates of associate degree programs 90–100% obtained jobs in private industry. Graduates included petroleum and nuclear safety technicians; most were coal miners. Bachelor degree holders, for the most part, found jobs in industry (90–100%). Those programs indicating exceptions to this ratio included five nuclear engineering and one environmental engineering program. No pattern emerged as to the distribution of graduates not entering industry. No general statement was appropriate to the employment of masters or Ph.D. graduates. Programs reported from 20% to 95% working in industry; from 10% to 60% in government; as many as 30% in consulting.

The diversity represented by these programs was reflected in the staffing configurations. Altogether, 231 full-time (58%) and 165 part-time (42%) faculty were recorded. Three patterns of staffing were readily identifiable. Approximately half of the programs relied exclusively or nearly so on full-time program faculty. Several programs were made up of a core program faculty supplemented by several people who were cost-centered in other departments. The arrangement may involve a specified proportion of time devoted to the program or may be as limited as offering one course in alternative years. The third method of staffing was practiced by multidisciplinary efforts which often did not lead to separate degrees, but frequently to special concentrations or certificates. Often one person was responsible for coordination of contributive efforts of faculty from many departments who were listed as part-time with regard to the energy program. The contribution of these faculty members may range from active participation in program administration, student advising, and curriculum decisions to assuming the responsibility for teaching a single course infrequently.

No meaningful student-faculty ratio could be developed due to the variance in methods of program staffing and because of differences in teaching loads and research commitments.

Several programs indicated internships or applied study terms were an integral component of the educational experience. Seven of the associate programs either required or contained an active option of internships; 13 of the bachelors programs did so; as did nine of the masters programs. It was an option in a few doctoral programs.

Several respondents singled out the applied study aspect as the most important component distinguishing their program from similar efforts. Some, particularly at the associate level, indicated that such experience was essential to the development of a well-qualified graduate. Many, especially at the bachelor level, noted that their graduates who have participated in an internship or applied study term have a measurable advantage in the job market over people who have no practical experience. Most programs boasted examples of students who, upon graduation, had been offered full-time positions with the firm or agency with which they had interned.

Very few programs had graduate follow-up data beyond entry level for more than a small number of individuals who had maintained personal contacts with faculty members. Many of the programs which replied in the affirmative were quick to state that it was on an informal basis. Those with formal follow-up procedures depended heavily upon program or department mail surveys.

Recruitment

Only one program respondent said recruitment was a major problem. Most said their recruitment efforts were adequate and several (particularly mining technology and nuclear technology and engineering programs) replied they, as a program did no active recruitment because student demand was high in response to high paying jobs awaiting graduates. Many programs, especially at the undergraduate level depended primarily or wholly upon university-wide recruiting programs.

The most common means of alerting potential students as to the existence of a program and its emphases and offerings was the descriptive brochure. These, often accompanied by a poster, were mailed to high schools and undergraduate departments. Frequently a return card was attached to or incorporated in the brochure to facilitate requests for further information. Department faculty or university recruitment personnel usually distributed brochures to students during high school career opportunities events.

Other recruiting aids or processes specifically mentioned were:

1) Word of mouth—especially among graduate programs. Some referred to "general school/department reputation".
2) Financial Aid/Scholarships—the availability of support money is considered by several programs to be a significant factor in recruiting efforts.
3) Referrals by employers—coal companies, in particular, often recommended personnel or potential personnel attend a specific school or program.
4) Answering inquiries—quick, detailed response to information requests was deemed by many to be very important. Most relied on form letters and a prepared packet. Smaller programs made a point of drafting personal replies.

Funding Sources

The topical, pervasive, and critical aspects of the energy education field were evidenced by the degree and widespread sources of research support. As would be expected, the U.S. Department of Energy was the most prevalent source of research money. Other federal sources included the U.S. Bureau of Mines; the Environmental Protection Agency; Health, Education, and Welfare; and the Nuclear Regulatory Commission. Many state agencies also supported projects.

The National Science Foundation was a major funding source, as was the Ford Foundation. Many industries, especially through institute contributions, supported a variety of research. The Electric Power Research Institute and the American Iron and Steel Institute were large funding sources. Oil and gas companies and utilities supported several research programs. Others noted were the Appalachian Regional Commission and the National Institute of Health. One program specifically mentioned a project with foreign support.

Student support included several sources and types traditionally available to people regardless of major and some which were unique or of more than usual significance to energy education.

University-wide scholarships were quite common, as were student loans. Most energy program students were employed during the summer and many worked during the school year; the work-study program was a common source of income. Research and teaching assistantships were available in most graduate programs. Many student jobs were supported through research funding.

Engineering students were often eligible for a cooperative work program. Many students had industry grant support, often in the form of traineeship. Many, especially in the associate programs, qualified for Basic Educational Opportunity Grants. Some students received support from professional societies; some were reimbursed for their education expenses by their employers.

Fellowships were common. Industry and the Department of Energy were major sources of fellowship monies; some were available through private endowment. No program respondent mentioned G.I. benefits as a major source of support. This may be an accurate reflection of the situation or it may be an oversight enhanced by discussing the question with faculty, rather than students.

Curriculum Development

Phase II researchers, in an effort to compile data relative to the procedural, administrative, and developmental constraints in the modification of curriculum materials, posed the following questions to faculty members who were interviewed: "What is the time required to implement a complete content change in a course?" and "What is the time required to implement a complete change in a program?" For the purposes of this study, a program was considered a course of study, either completely prescribed, or containing options, with an identity of its own and standard rules and procedures, the satisfaction of which leads to a degree, certificate, or diploma. A course was considered a unit of a program, in which a body of knowledge is presented, the satisfactory completion of which leads to the awarding of a predetermined or individually arranged number of credits.

The questions were asked of faculty members in each of the program's areas described in this review. It was believed that the compilation of such information could provide useful and informative comparisons by degree level, by geographic location, and by other related variables. It was also thought that this information would provide insights into the flexibility or lack of flexibility in the development and modification of courses and programs. This information holds potential interest to those considering the development of curricula, to those currently offering, but considering the modification of curricula, and to potential funding sources.

Most energy education programs were able to implement a new course in a few months, usually for the upcoming semester or quarter. Thirteen answered that they could initiate a new course immediately. Several noted that a change at the graduate level is easier to implement than at the bachelors level.

Most changes in program curriculum, requirements, and sequences were possible in less than a year's time. A few programs could implement changes immediately, some took slightly more than a year, and some were subject to extensive process which took three to four years. As with single course changes, faculty noted that it was a simpler process to change graduate rather than undergraduate programs.

Preparation of students for specific occupations or for a general occupational area was discussed during interviews. To verify data and maintain consistency, respondents were mailed occupational check lists specific to their program area(s). They were asked to indicate those occupations listed for which their graduates are qualified and to add appropriate occupations not listed.

The Associate level programs included in this energy volume are of three basic types: Mining Technology, Petroleum Technology, and Nuclear Engineering/Safety Technology. Graduates were prepared for the following occupations:

Entry Level Miner (Coal)
Petroleum Engineer Technician
Industrial Radiologist
Radio-Chemistry Technician
Health Physics Technician
Property Analysis Technician (Petroleum)
Reactor Operator
Research Assistant
Air Pollution Control Technician
Environmental Tester/Analyst
Drilling Technician
Physical Science Technician

Bachelors level programs discussed prepared students for the following occupations:

Chemical Engineer
Electrical Engineer
Energy Efficiency Technician
Energy Engineer
Geophysicist
Mechanical Engineer
Metallurgist
Mineralogist
Mineral Processing Engineer
Mining Engineer
Mining Geologist
Agronomist
Bacteriologist
Biochemist
Biophysicist
Chemist
Ecologist
Environmental Control Technologist
Nuclear Plant Operator
Strip Mine Inspector
Solar Energy Technician

Nuclear Engineer
Nuclear Technician
Petroleum Engineer
Petroleum Geologist
Physicist
Power Reactor Operator
Resource Conversion
  Technician
Industrial Engineer
Safety Engineer
Petroleum Geologist
  Technician

Graduate level programs prepared people for the above occupations and, in addition, the following:

Environmental Physicist
Mechanical Engineer
  (Conversion)
Energy Policy Analyst
Environmental Monitor
  Specialist
Environmental Science
  Technician
NRC License and Standards
Electric Power Engineer
Energy Management
  Systems Analyst
Industrial Hygienist
Oceanographer
NRC Inspector

Employment opportunities for graduates entering most of the above occupations were very good. Most had several job offers or moved into a position for which they had made specific preparation. The job market for women and minorities in most of these occupations was extremely good.

The image of energy programs within the institution as reflected by attitudes of colleagues and other students was highly favorable. No program reported any difficulties in this regard. The energy programs which were a part of or an outgrowth of an established engineering program generally enjoyed the same reputation as the parent department.

The need for additional curriculum materials was of little concern to all but the persons interviewed representing the Associate level. Finding a happy medium appeared to be the goal. Existing materials were often too narrowly focused or too broad; the reading and/or technical level was commonly too high or beneath the students' level.

During Phase I of the National Environmental/Energy Workforce Assessment, researchers noted that a large number of the persons interviewed who employ persons with environmental or energy training/education observed that many graduates were being produced who are deficient in the much needed communication (oral and written) and financial management skills. During Phase II, faculty of the environmental/energy programs were questioned regarding their own attitudes on this subject in order to ascertain the consistencies or discrepancies in perceptions between academia and prospective employers of graduates.

Respondents in engineering-based programs generally agreed that communication skills were a problem with students entering the programs. These programs attempted to deal with the problem by such means as requiring students to prepare technical reports and participate in oral presentations within specific courses, and by encouraging or requiring the development of a thesis or dissertation. The efforts to enhance student communication skills within engineering programs were often limited. The reasons for this included: a) communication courses that may be chosen as electives were rarely geared toward the specific needs or purposes of engineering; and b) some engineering programs have been under pressure to reduce the number of credits required for a degree, and as few engineering courses can be deleted, those courses such as technical report writing were often eliminated from the curriculum.

A similar, though slightly less emphatic, response was elicited from engineering faculty regarding student/graduate financial management skills. Within most engineering departments, courses were available that deal directly and/or indirectly with engineering economy and financial management.

Faculty teaching in associate programs who responded to the question felt the level of communication skills was a common and major difficulty affecting the student's presentation of material and evaluation of the learning process through means other than hands-on demonstration and practice.

Respondents from other programs replied that the skills levels in communication and financial management varied greatly from student to student. Most attempted to deal with the problems by advising students in need of upgrading to take appropriate electives or to avail themselves of the services of special tutoring centers which were free and open to all students on many campuses.

Criteria for Program Selection

The criteria for energy program selection in Phase III included the following types of program descriptions, in addition to at least two (and preferably more) energy related courses required for program completion: (a) technician level education/training programs (radiation technician for nuclear power plants, coal mining, and/or petroleum technicians); (b) energy management and/or policy; and (c) engineering programs emphasizing nuclear power, alternative energy sources, wind, solar, etc.

The 159 energy programs included were geographically located in 41 states and one territory. The greatest percentage (39.6%) of these programs lead to four-year and graduate level degrees. When the four-year programs (17%) and the graduate programs (13.8%) were included, approximately 70% of the total energy programs are categorized as four-year and/or graduate level degree offerings.

Overall, we found the picture of the energy education field to be healthy and productive. Increasing public awareness of America's condition respective of energy has had a positive effect on these programs. Phase II researchers met with representatives of programs in nuclear engineering/technology, mining engineering/technology, petroleum and natural gas engineering, geology, energy engineering, and policy and management.

Some nuclear engineering programs noted that the nuclear program on campus had become more accepted among their students. This was considered by some to be an indication that public opposition to nuclear power plants was waning and that the slowdown on power plant construction might be overcome with a resultant increase in jobs in the field. Others were not so optimistic and felt that demand for graduates in this field would remain stable or decline. Still others contended that employment potential for graduates in this field had been growing steadily and had not suffered in the recent past.

Energy management and analysis was considered to be among the most crucially needed areas to be developed in the near future and, consequently, the most promising for employment opportunities. Others noted that programs with teaching and research commitments to alternative energy sources and technologies were only beginning to come into their own. Feelings were mixed as to the future for such programs, but it was clear that without substantial outside funding for these endeavors there would not be any large scale effort made to develop programs in the alternative energies. There was frequent expression though, of the need for an expansion of programs which were specifically designed to train/educate experts in these areas (e.g., solar, geothermal, wind., etc.) of alternate energy technology.

SUMMARY

Essentially we found that the future looks bright for energy programs, as a whole. Specific program future may be dependent upon general public attitudes, unanticipated economic factors, and national energy policy decisions.

Graduates of energy programs generally have highly sought after skills and have little difficulty finding employment. This condition is expected to continue and improve even as enrollments and subsequent graduates increase, simply because energy related expertise is in great demand.

APPENDIX A: ENERGY PROGRAMS REVIEWED IN PHASE II

State	Institution	Program	Degree
CA	University of California-Berkeley	Nuclear Engineering	B.S. M.S. M.S.E.S. M.E. Ph.D.
CT	Hartford State Technical College	*Nuclear Engineering Technology	A.S.
FL	University of Florida	Nuclear Engineering	B.S. B.S.E. M.S. M.E. Ph.D. Engr.
GA	Georgia Institute of Technology	Energy Engineering	Adv. Cert.
	Southern Technical Institute	*Nuclear Safety	A.S.
IN	Purdue University	Nuclear Engineering	B.S.N.E. M.S. Ph.D.
KS	Kansas State University	*Chemical Engineering	B.S. M.S. Ph.D.
KY	Morehead State University	Mining Technology	A.A.S.
	Pikeville College	Mining Technology	A.M.T.
	University of Kentucky	Energy (Coal) & Engineering	M.S. Ph.D.

State	Institution	Program	Degree
MA	Massachusetts Institute of Technology	Mineral Resources Engineering & Management	S.M. Engr. Sc.D./Ph.D.
		*Nuclear Engineering	S.B. S.M. N.E. Sc.D./Ph.D.
NJ	Princeton University	Energy Conversion & Resources	Not Degree Granting
NM	University of New Mexico	Nuclear Engineering	M.S. Ph.D.
NY	Columbia University	*Nuclear Engineering	B.S. M.S. N.E. E.Sc.D.
	Cornell University	College Program in Energy Conversion	B.S.
	Polytechnic Institute of Brooklyn, New York	Energy Engineering and Policy	Cert.
	Rensselaer Polytechnic Institute	*Nuclear Engineering	B.S. M.S. M.E. Ph.D.
OH	Muskingum Area Technical College	Petroleum Engineering Technology	A.A.S.
OR	Oregon State University	Nuclear Eng. Technology	B.S.
		Nuclear Engineering	B.S. M.S. Ph.D.

State	Institution	Program	Degree
PA	Carnegie-Mellon University Carnegie Institute of Technology	*Environmental Engineering	B.S. M.S. M.E. Ph.D.
	The Pennsylvania State University	*Minerals Processing	M.S. Ph.D.
		Mining Technology	A.A.S.
		Mining Engineering	B.S. M.S. M.E. Ph.D.
		*Nuclear Engineering	B.S. M.S. M.E. Ph.D.
		*Nuclear Engineering Technology	A.A.S.
		Petroleum & Natural Gas Engineering	B.S. M.S. Ph.D.
	University of Pennsylvania	Energy Engineering	M.S.E.
		Energy Management & Policy	M.S. Ph.D.
TN	University of Tennessee	*Nuclear Engineering	B.S. M.S. M.E. Ph.D.
TX	Lamar University	Energy Resources Management	B.S.
	Texas State Technical Institute	Nuclear Systems Technology	A.A.S.

State	Institution	Program	Degree
UT	Brigham Young University	Chemical Engineering, Energy and Environment	B.S. M.S. Ph.D.
WV	Bluefield State College	Mining Engineering Technology	A.S. B.S.
	West Virginia Institute of Technology	Mining Engineering Technology	A.S.E.M.T. B.E.M.T.
	West Virginia University	Engineering of Mines	B.S. M.S.
		Mineral Processing Engineering	B.S. M.S.
		Mineral Resources Economics	M.S.
		Petroleum Engineering	B.S. M.S.

APPENDIX B: ENERGY PROGRAMS LISTED IN PHASE III

Degree Level	No. of Degrees	% of Total
Certificate	2	1.3%
Certificate; Two-Year	2	1.3%
Certificate; Two-Year; Four Year	1	0.6%
Certificate; Graduate	1	0.6%
One-Year	1	0.6%
One-Year; Two-Year	23	1.3%
Two-Year	33	20.8%
Two-Year; Four-Year	1	0.6%
Two-Year; Four-Year; Graduate	1	0.6%
Four-Year	27	17.0%
Four-Year; Graduate	63	39.6%
Graduate	22	13.8%
N/A	3	1.9%
TOTAL	159	100.0%

Employment, Education, and Recent Energy Legislation*

Wayne Stevenson, Oak Ridge Associated Universities, Oak Ridge, Tennessee

INTRODUCTION

The first step in planning education and training programs aimed at providing for energy-related employment needs is properly anticipating areas of relatively rapid growth in demand. Growth in accord with historical rates or economy wide trends is relatively easy to accommodate as some long run equilibrium is already established between labor demand and the programs designed to supply trained workers. In the case of rapid or significantly altered development, however, unprecedented growth can create uncertainty concerning the proper institutional response. Programs initiated before skill requirements are well defined can result in serious mismatches between the skills acquired by students and those required by employers. On the other hand, starting after the market for graduates is established can contribute to an over supply of trained workers competing for a limited number of positions. In the face of this uncertainty, maximizing the likelihood of program success requires (1) accurate knowledge of the future demand for skilled labor, (2) information concerning the growth of new programs to supply workers, and (3) good intuition.

Fuel supply interruptions, rising prices, international politics and public policy combine to make the energy sector of the domestic economy an area of certain growth and change during the next decade. Unusual growth in employment demand and, in some cases, the emergence of new occupational categories can be expected in some areas of energy development. Research and development, construction, operation, and maintenance activities are all expected to be affected.

---

* This report is based on research reported in much greater detail by the author in *Employment, Education and Training Implications of the National Energy Act*, report submitted to Division of Labor Affairs and Manpower Assessment, DOE, October 1979. Portions of this paper have also appeared in Stevenson and Doggette, "Energy-Related Employment and Vocational Education During the 1980s," in *Curriculum Development Needs for Vocational Education: New and Changing Occupations*, National Center for Research in Vocational Education, Ohio State University, January 1980.

The purpose of this paper is to review recent energy policy and assess its expected impact on employment, education, and training. In some cases a significant institutional response is already evident. In others, sometimes because public policy is unclear, a wait-and-see attitude prevails. In any case, proper planning requires obtaining the best available information on expectations of future labor supply and demand. Among other things this requires staying abreast of developing policy.

Recent Developments in Energy Policy

National policies which influence the development and use of energy resources are not new. For example, the price regulation of natural gas began with the 1938 Natural Gas Act, and oil import quotas began in the 1950s. The supply interruptions and price increases associated with the formation of OPEC and the 1973–1974 oil embargo, however, demonstrated the need for a new, coherent energy strategy. So in April 1977, the President outlined a plan calling for legislation aimed at balancing domestic supply and demand for energy. This *First National Energy Plan* (NEP I) had the following three principle objectives:

Immediate Objective: To reduce dependence on foreign oil and to reduce vulnerability to supply interruption.

Mid-Term Objective: To keep U.S. oil imports low in preparation for the period when world oil production approaches its capacity.

Long-Term Objective: To develop renewable and inexhaustible energy sources to sustain long-run economic growth.

These objectives were formulated under the assumption that in the foreseeable future, the U.S. would be going through a major energy transition. NEP I called for some specific legislative action which would help smooth out the impact of inevitable changes. The basic underlying strategy, which continues to guide energy policy, involves the following:

1) Conservation and fuel efficiency to reduce the growth in demand for energy to two percent per year.
2) Rational pricing of energy resources to allow domestic prices to more closely reflect the higher world prices.
3) Conversion from oil and gas use to coal and other conventional fuel sources.
4) Development of solar and other unconventional energy sources.

In 1977, the use of light-water nuclear reactors was seen as an important source of electricity generation. Public concern over health and safety problems, radioactive waste disposal and nuclear proliferation have left the role of nuclear power less certain than at the time NEP I was presented. National policy toward nuclear energy continues to be a major area of confusion in the formation of long run energy objectives and strategies.

After months of debate and deliberation, Congress passed legislation designed to fulfill many aspects of NEP I. Signed into law on October 15, 1978, the legislation became known as the *National Energy Act* (NEA). The Act consists of five separate laws (PL95-617 through PL95-621), each designed to respond to different aspects of the energy problem as outlined in the National Energy Plan. With their primary purpose, the five pieces of legislation are:

THE NATIONAL ENERGY CONSERVATION ACT

To provide for regulation of interstate commerce so as to reduce the growth of demand for energy through (a) energy conservation and (b) development of solar and other alternate energy sources.

THE POWER PLANT AND INDUSTRIAL FUEL USE ACT (COAL CONVERSION ACT)

To promote the use of fuels other than oil and natural gas in the production of energy in new and existing electric power plants and other major fuel-burning installations.

THE PUBLIC UTILITIES REGULATORY POLICIES ACT

To alter price and other regulations on public utilities in such a way as to encourage conservation and efficient use of electricity and to improve wholesale distribution of electric power while maintaining equity in the rate structure.

THE NATURAL GAS POLICY ACT

To eliminate the distortions caused by two-tiered (interstate/intrastate) pricing of natural gas and to remove "outmoded regulatory burdens" associated with sales in interstate markets.

THE ENERGY TAX ACT

To provide tax incentives consistent with the purpose of (a) The National Energy Conservation Act and (b) The Coal Conversion Act.

The major provisions of each law are summarized in Table 1. They are consistent with their stated purpose and conform closely to the strategy outlined in NEP I. Together these provisions establish a fairly consistent set of tax incentives, grants, loans, and regulations aimed at balancing domestic energy supply and demand.

But this is not the end of the process. Even in the short period since passage of NEA, new policy directives have come into being. In 1979, the President submitted to Congress, a *Second National Energy Plan* (NEP II). In addition to reaffirming the provisions of the National Energy Act, NEP II establishes some new initiatives. The planned, phased decontrol of domestic oil prices and a windfall profits tax on oil companies are the most notable recommendations; but other proposals aimed at strengthening incentives for conservation and alternate fuel use are also included.

But even NEP II has been superseded by initiatives announced in a July 15, 1979 Presidential address. The President recommended at this time that (1) a freeze on U.S. oil imports be imposed at or below the level of 8.5 million barrels per day, (2) a massive program be instituted in the research and development of synthetic fuels, and (3) an energy mobilization board be created to expedite priority projects through the licensing and regulatory process. Added to other energy policies, the goal is to reduce oil imports to less than half their current level. Oil price decontrol and the ceiling on oil imports have been administratively improved by authority previously granted the President. Other than to provide $1.35 billion to help low income families pay home heating bills, the remaining 1979 legislative initiatives were awaiting congressional action in January, 1980.

It is clear that national energy policy is not static but part of a constantly changing process of development and transition. There is, as a result, considerable disagreement among forecasters over the net effect of these policies. There is agreement, however, that energy policy, economic conditions and other factors will result in a significant shift in the way in which the nation's energy is produced. Table 3 shows how the Energy Information Administration of DOE expects the energy supply mix to change by 1995.

The shift from oil and gas to coal and other sources is the principal characteristic of the energy transition. Accompanying this shift will be a corresponding reallocation of labor and a change in capital construction activity. A trained experienced work force will be needed in support of this shift.

TABLE 1. Summary of NEA Provisions and Their Strategic Purpose

Provision	Purpose
The National Energy Conservation Act	
Residential energy audits	Conservation
Energy audits of federal buildings	Conservation
Weatherization grants	Conservation
Federal mortgage market modifications	Conservation and solar development
$900 Mil. for audits of public buildings	Conservation
Penalties to automakers	Conservation
$100 Mil. for solar demonstration projects	Solar development
$98 Mil. for photovoltaic projects	Solar development
Power Plant and Industrial Fuel Use Act	
Prohibitions on use of oil and/or gas by public utilities and large industrial users	Conversion from oil and gas
$180 Mil. assistance to "boom towns"	Conversion from oil and gas
$100 Mil. for railroad transportation	Conversion from oil and gas
$800 Mil. in loans for pollution control equipment	Conversion from oil and gas
Public Utilities Regulatory Policies Act	
Co-generation provisions	Unconventional energy development
Loans for design and construction of small scale hydroelectric facilities	Unconventional energy development
National Regulatory Research Institute	Rational pricing
New Coal Research Institutes	Conversion to coal
National Gas Policy Act	
New wellhead pricing procedures	Rational pricing
Incremental pricing of new gas	Rational pricing

Energy Tax Act

$300 tax credit for residential energy conservation measures	Conservation
$2200 tax credit for residential solar energy investments	Solar energy development
Gas guzzler tax on autos	Conservation
Federal excise tax exception for gasohol	Unconventional energy development and conservation
Business tax changes for investments in coal conversion, solar, wind, geothermal, cogeneration and other energy saving equipment	Conservation, oil and gas conversion, solar and unconventional energy development
Tax changes related to use of large gas and oil-fired boilers	Conversion from oil and gas

Employment, Education and Training for Energy-Related Jobs

On the whole, there appears to be substantial agreement that energy supply changes over the next decade will create more jobs than they eliminate.[1] The expected impact differs significantly, however, depending on industry, occupation and geographical region. The purpose of this section is to analyze labor demand by various energy activities. The aim is to improve efforts at planning institutional response by reviewing the most recent evidence on energy-related employment growth. Where appropriate, suggestions for future program development are also made.

PRODUCTION OF CONVENTIONAL FUELS

While efforts to conserve energy and encourage the development of unconventional sources of energy tend to receive the greatest public notice, some of the greatest employment impacts are anticipated in conventional fuels production. Significant changes are anticipated in coal mining and transportation, oil and natural gas production, and nuclear power generation.

COAL MINING AND TRANSPORTATION

A major strategy of national energy policy is to encourage coal conversion to reduce the nation's reliance on oil and natural gas. Although a shift to coal would be expected in response to higher prices for oil and gas, the National Energy Act serves to hasten the transition. The following three important restrictions are imposed by NEA (more specifically by the Power Plant and Industrial Fuel Use Act):

1) New electric power generating facilities are prohibited from using oil and natural gas.
2) Natural gas and oil use is prohibited in new major fuel burning installations using over 100 million BTUs per hour to fire a boiler.
3) Natural gas is to be prohibited after 1990 as a primary fuel in existing power plants.

TABLE 2: Major Energy Issues before Congress, January, 1980

Windfall Profits Tax to extract oil company profits from deregulation of domestic oil prices.

Creation of Energy Security Corporation to direct development of synthetic fuels from coal, oil shale, biomass, and unconventional gas.

Provision of incentives for development of heavy oil extraction methods, enhanced gas recovery methods, and oil shale processing.

Agricultural, Forestry, and Rural Energy Act—would establish the goals of net energy independence for agriculture and forest production, processing and marketing; and a 50 percent reduction in oil and gas use by rural residents and communities by the year 2000.

Gasohol Motor Fuels Act—would establish a national goal of 60,000 barrels/day (nearly 1000 million gallons/year) of alcohol fuels by 1982 and a volume of alcohol fuels from renewable resources equal to 10 percent of estimated U.S. gasoline consumption in 1990.

Creation of new incentives for residential, commercial, and public utility conservation of oil.

Increased spending for mass transportation and automobile fuel efficiency.

TABLE 3. Percent Distribution of Primary Energy Sources

Energy Source	1977 (Percent)	1985 (Percent)	1990 (Percent)	1995 (Percent)
Coal	19.98	24.72	30.13	35.55
Gas	25.83	21.87	18.76	15.90
Oil	47.76	42.72	38.64	34.37
Nuclear	3.39	7.16	9.10	10.79
Other	3.04	3.53	3.37	3.38
Total	100.00	100.00	100.00	99.99

Source: Adapted from Energy Information Administration, *Energy Supply and Demand in the Mid-Term*, U.S. Department of Energy, April 1979.

Unless constrained by health and safety legislation, environmental regulations, inadequate transportation facilities, or other institutional and economic factors, this strategy is expected to increase coal production to nearly one billion tons by 1985. Projections of the demand for coal miners are contingent on tons mined per year, output per worker, the mix of surface and deep mining, and the number of workers leaving the industry. If, for example, one billion tons are mined in 1985 and production per worker remains constant, approximately 100,000 new jobs will exit in 1985. It has been estimated that 40,000 new hirings per year will be needed to meet this demand if the annual exit rate from the industry does not change.[2] Another 100,000 workers may be needed for mine construction and coal transportation activities.[3] The greatest absolute increase in coal-related employment is expected in the eastern region where an additional 68,000 deep miners may be required (see Table 4). Relative to the existing work force, however, the most rapid growth will be in western surface mine employment which is expected to grow at an annual rate of well over 15 percent (see Table 4).

TABLE 4: Labor Requirements and Output by Region, 1975 and 1985

	Region*					
	West		Central		Appalachia	
Labor Requirements	1975	1985	1975	1985	1975	1985
Surface	4,860	24,700	9,190	14,300	41,450	41,900
Deep	4,530	53,200	9,150	19,100	121,030	188,800
Output (million tons)						
Surface	77.7	392.9	72.9	111.3	209.4	195.5
Deep	11.6	136.0	32.5	55.3	249.3	368.0

* West: Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming; Central: Illinois, Indiana, Iowa, Kansas, Missouri, Oklahoma, and Texas; Appalachia: Alabama, Arkansas, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Source: U.S. Bureau of Mines, *Minerals Yearbook*; (Washington, D.C.: U.S. Government Printing Office, 1975). Joe G. Baker, "Coal Mine Training Requirements," paper delivered at the National Education, Labor, and Business Affairs Conference, Washington, D.C., January 1979; and coal production forecasts developed for the U.S. Department of Energy by CONSAD Corp., 1977.

Expected coal industry employment growth will put a strain on existing programs which have replaced on-the-job training traditional in the industry. Legislative changes during the last decade have forced the coal mining industry to establish procedures for training and retraining. The Federal Mine, Health, and Safety Act of 1969, for example, requires safety training for new and experienced miners. Formal skill training is also required for mechanics, electricians, foreman, and other supervisors. The National Bituminous Coal Wage Agreements of 1974 and 1978 also make annual retraining mandatory for all employed miners.

Coal mine training programs have been identified in 36 separate vocational-technical schools and community colleges. Thirty-one of these are located east of the Mississippi River, and 32 have been created since 1972. A variety of training programs are provided. They range from the initial 40 hours of required safety training for new miners to courses for experienced miners preparing for certification tests in specific areas. Associate Degree programs often include both employed and potential miners. Equipment maintenance programs also exist for both surface and underground mining. The programs tend to be designed for the specific needs of local companies and receive the approval of local unions.

It appears that a sufficient number of well established programs exist in the East. In the West, however, the demand for miners will tax the ability of schools to provide training. Growth of new programs in the West is inevitable and probably desirable. Care must be taken to coordinate these with the demand from companies located in proximity to the technical schools.

As in mining, the greatest growth in demand for transportation facilities is in the West. An extensive survey of the nation's railroads revealed that employment related to rail transportation of coal is expected to grow by 55,000 during the 1980s.[4] This would represent an annual growth of about 4.5 percent or 6,000 workers per year. Some of these jobs would be for electricians, carpenters, masons, and train crew personnel. If current employment patterns persist, however, 80 percent would be for unskilled or semi-skilled manual workers who typically receive training on the job.

OIL AND NATURAL GAS PRODUCTION

Public policy toward the oil and natural gas industry also appears to be favorable to increased exploration and extraction activity. Although the future of the excess profits tax is not known at the time of this writing, decontrol of prices will bring the real price of gas and oil more in line with replacement costs. The result will be to make domestic production more attractive and encourage the use of new enhanced recovery techniques. Whether the outcome will be increased production is not known, but the current trend of increased drilling activity is almost certain to continue.

Conditions have become particularly favorable to exploration activities. For example, the wellhead price of natural gas increased at an average annual rate of 10.44 percent between 1970 and 1977.[5] Over the same period, the wellhead price of domestic crude oil increased at an even more rapid 15.21 percent annual rate. Interestingly, over this same period, the exploratory drilling costs per successful oil and gas well only increased about three percent per year. The slower than expected increase in average costs of exploratory drilling can be explained by the rising successful drilling rate. Twenty-seven percent of all exploratory oil and gas drilling was successful in 1977 as compared to 16.5 percent in 1970. Thus, throughout the decade, the economic environment has been favorable to exploration and extraction activities.

So refining, transportation, distribution and other activities associated with oil and gas production will vary with total output. But, exploration drilling is certain to increase. The Bureau of Labor Statistics estimates a corresponding growth in employment. The number of oil and gas extraction workers is projected to exceed 600,000 by 1985[6] (a 50 percent increase). Such a growth rate would greatly exceed forecasts for the labor force as a whole.

An increasing number of geologists and geophysicists will find employment in oil and gas exploratory drilling activities. Educational programs for training these individuals are well established. A limited number of programs exist, however, to train other oil and gas industry workers. Fifteen vocational schools and community colleges have been identified with petroleum programs, but most of their placements are in refining rather than drilling activities.[7] Of these, the most successful programs are those which work closely with petroleum companies to provide the proper mix of skills.

NUCLEAR POWER PRODUCTION

The future role of the nuclear power industry is the source of enormous uncertainty. What can be expected with some certainty, however, is (1) new, tougher licensing procedures, (2) closer federal supervision, and (3) more stringent certification requirements for power plant operators and nuclear technicians involved in all segments of the industry: mining, milling, uranium enrichment, power plant operation, waste disposal, and reprocessing. Approximately 30,000 technicians were employed in these activities in 1977. About 4500 of these, roughly half the number forecast a decade ago, perform reactor operation and maintenance duties.[8]

As in the past, educators will have difficulty planning for the needs of the nuclear industry. Of the 18 known nuclear programs in technical schools and colleges, two have stopped training due to recruiting difficulties and high operating costs. Furthermore, a study conducted in 1978 suggests that fewer than 100 employees in the nuclear utility industry held associate degrees in nuclear technology.[9]

Thus, while substantial retraining may take place, uncertainty concerning the rate of future growth within the industry makes nuclear power related training programs a fairly risky proposition. Without a commitment from a nearby utility company, few institutions will be willing to incur the startup costs necessary for a sound program.

ENERGY CONSERVATION

In addition to stimulating the supply of conventional energy supplies, a major strategy is to slow the growth of energy demand through conservation and improved efficiency. For example, the National Energy Conservation Policy Act of 1978 requires most regulated and unregulated utilities and home heating suppliers to provide residential energy audits. The exact nature of the audits has not been established, but homeowners are to be provided with cost and savings estimates of energy saving measures and the names of approved installers and lending institutions. Federal and other public buildings are also to be audited.

Incentives to carry out the conservation measures are reinforced by the Energy Tax Act. Homeowners are given a 15 percent tax credit, up to $300, for the installation of energy saving devices. A similar credit of up to $2200 is to be given for investments in solar or other alternate energy equipment.

In addition to generating employment for weatherization, furnace modification, and other conservation activities, this recent conservation legislation will create demand for energy conservation technicians to conduct energy audits. It has been estimated that as many as 8600 on-site auditors may be needed each year through 1985.[10] Until final regulations are enacted, however, little employment impact can be expected. As a result, few educational institutions claim to have programs aimed at training energy conservation personnel.

Also inhibiting institutional response is the disagreement over what skills an energy conservation technician ought to have. The Tennessee Valley Authority's home audit program may provide the best guidelines. Its energy conservation adviser must be able to conduct an on-site energy audit to determine deficiencies in both commercial and residential buildings. The adviser must also be able to make inspections after conservation measures have been taken. Then if additional measures are needed, the adviser must be able to convince the owner of the mutual value of installing additional materials. For these jobs, TVA has been employing graduates with two and four year college degrees who have a physics and math background. Short courses and on-the-job training have been used to supplement these general skills. Other utilities are planning to retrain customer service representatives to conduct audits and disseminate conservation information. A series of short courses would provide the necessary background.

The institutional response to this uncertain situation has been small but can be expected to become more evident as energy conservation programs develop. Some existing programs may serve as models. Project EFFECT, for example, is a three-year program in curriculum development focusing on energy conservation, technology, and training. The project, administered out of Indiana University-South Bend, has developed a curriculum designed to provide background needed to conduct (1) energy audits of residential and light commercial buildings and (2) community energy conservation information programs. A six-month program including 588 hours and two months of field work is being tested.

At least ten vocational schools are also experimenting with a program designed by Technical Education Research Center-Southwest. Recognizing that there is little agreement on the skills necessary, four areas of general technical training are identified: research and development, production, use and conservation. A major component of the two-year, 1470 hour curriculum is training in new technology.

Whether or not the energy conservation technician will become an enduring occupation requiring specific training may depend on more than federal conservation regulations. As energy conservation measures become more economically advisable, training will be needed to provide for both the public and private sectors. Initially, however, it may be wise to coordinate programs with known employers.

Unconventional Energy Source Development

A crucial ingredient to successful educational planning is foresight. In the area of energy development, this involves looking beyond conservation and conventional fuels production. National strategy for easing the energy transition also involves the development of unconventional energy sources such as solar, biomass, alcohol, and synthetic fuels. In addition to research and development activities, solar and unconventional fuels production may create jobs which require special skills. Although knowledge is incomplete in this area, there are some early indications of future employment requirements.

SOLAR

Tax credits, assistance programs, demonstration projects, and a variety of other provisions constitute a program designed to encourage development and use of solar energy systems. Jobs will no doubt be created in the design, manufacture, installation, and maintenance of a variety of solar energy systems. In the foreseeable future, however, the major employment impact will be in the flat plate collector industry where the basic technology for space and hot water heating has been tested and proven. Between 1975 and 1977, sales of solar flat plate collectors have been reported to have increased tenfold.[11]

Even if the future use of solar flat plate collectors were known, it would be difficult to project employment and training needs. After a survey of existing studies, Mason and Armington conclude that ". . . there is considerable divergence among estimates of direct labor requirements for solar technologies."[12] Some of this variance can, no doubt, be explained by the early stage of development in the industry. Inefficient firms have not been driven out by the competition and economies of large scale production have yet to set in. So while employment is almost certain to grow, forecasts based on current labor/output relationships are likely to badly overestimate the need for training.

On the supply side, programs have developed so rapidly that educators must be careful to constantly monitor their programs and coordinate offerings with local industry needs. Before planning a program, educators should conduct a very thorough analysis of local supply and demand conditions in the solar industries. The Solar Research Institute and the four regional Solar Energy Centers (Boston, Minneapolis, Atlanta, and Portland) should be contacted for their most current information.

BIOMASS AND GASOHOL

Biomass energy involves the use of agricultural crops and residues, animal and human waste, municiple solid waste, wood and other biodegradable material for direct combustion or to produce liquid or gaseous fuels. Although there is potential for significant energy production in these areas, little is known about employment requirements. A preliminary analysis suggests that a limited number of jobs will be created by using animal manure to produce methane gas, and the jobs created in the wood harvesting industry do not require formal training or education.[13]

A major activity in this area of energy production is the use of a variety of agricultural crops, food processing wastes, and other residues for the production of alcohol. While the majority of this activity is in the principal agricultural states, DOE reports some alcohol production and research in virtually every state. Over two-thirds of the states also have training programs and workshops.[14]

A recent survey has indicated that approximately 200 million gallons of 199 proof ethanol could be produced for use in gasohol during 1980.[15] Forty to 70 million gallons per year of this capacity would have to come from facilities requiring extensive modifications. The remainder could be obtained from facilities already under construction. By 1982, a capacity to produce 300 million gallons of alcohol for mixture with gasoline could be achieved. Most of this production would be from small and medium size distilling operations. Employment, education, and training implications of this development are being analyzed by Oak Ridge Associated Universities.

SYNTHETIC FUELS

Synthetic fuels production typically includes the production of oil and natural gas substitutes from relatively abundant hydrocarbons such as coal and oil shale. The synfuels goal set by President Carter calls for production of 2.5 million barrels per day. Such a production level in the foreseeable future would require substantial amounts of federal aid to reinforce the incentives produced by the rising world price of petroleum.

In addition to the question of economic profitability, a major constraint to synfuels development appears to be in the availability of appropriate workers for construction and operation of facilities. Critical labor shortages, it has been estimated, could restrict synthetic fuels output to less than 2 million barrels per day by 1990.[16] Some estimates put the demand for additional professional employment (including managers, engineers, and draftspersons) at 24,000 during the period between 1985 and 1990. This (according to Pace Co. Consultants and Engineers), represents more than half of today's 45,000 people who have the required skills for this work.[17] While the 210,000 construction workers needed to build synfuels facilities represents less than 5 percent of 1978 construction employment, local shortages could develop. The critical skills will be for pipefitters, boilermakers, ironworkers and welders who can weld to nuclear specifications.

Concentrating on the expected shortage of engineers, Bechtel Corporation estimates the following demands associated with the 2.5 million barrel per day goal: 10,000 engineers in 1987; 11,000 in 1988; and 9700 in 1990. As many as 1800 chemical engineers would be needed in the late 1980s. Five hundred of these would be needed as part of the permanent operations and maintenance work force.[18] Approximately 7500 chemical engineers are currently graduated each year.[19]

Because of the time required to train and educate engineers, educators should begin planning early for the expected demand for appropriately qualified engineers later in the decade. If the synfuels program becomes a reality, unprecedented numbers of chemical and construction engineers will be needed with knowledge of synthetic fuels production.

CONCLUSIONS

Institutions providing education and training in areas critical to future energy development will play more than a passive role in the energy transition. Those responsible for planning programs will have to do more than respond to opportunities as they arise. Failure to recognize needs before they develop, particularly where lengthy training is required, may result in critical shortages. There is more at stake, however, than a delay in the implementation of new technologies. Labor is an important component of construction, operation and maintenance costs. As a result, labor supply and demand conditions may ultimately affect commercial feasibility and the rate of diffusion of energy systems. The direction of future energy growth could conceivably be altered by an inadequate supply of certain critical skill groups.

The purpose of this paper has been to document recent energy policy and related employment, education and training responses. Keeping a close watch on new energy policy developments and anticipating labor demands is, of course, important. Predicting the supply forthcoming from other programs and coordinating curricula where appropriate is also vital to planning a successful program. Cooperation with future employers, labor unions, and others involved in the market for trained workers is also prerequisite to successful placement of graduates. Finally, however, good instinct and timing are the crucial ingredients if a program is to help satisfy the need for energy-related personnel.

REFERENCES

1. Sathaye, Jayant, and Ruderman, Henry, *Direct and Indirect Impacts of A National Energy Plan Scenario*, Energy and Environment Division, Lawrence-Berkeley Laboratory, 1979; Nordlund, Willis and John Mumford, "Estimating Employment Potential in U.S. Energy Industries," *Monthly Labor Review*, Volume 101, No. 5, May 1978; and U.S. Department of Energy, *Analysis of Administration Oil Price Decontrol and Tax Proposals Using Macroeconomic and Energy Models*, Annex 2 to Appendix C of NEP II, August 1979.
2. Joe G. Baker, "Coal Mine Training Requirements, 1975–1985," paper given at the Education, Business, and Labor Affairs Conference, Washington, D.C., January 1979.
3. Sathaye, Jayant and Henry Ruderman, *An Assessment of National Consequences of Increased Coal Utilizations*, prepared for U.S. Department of Energy, February 1979.
4. Witten, John M. and Samir A. Desai, *Rail Transportation Requirements for Coal Movement in 1985*, report to the Office of the Assistant Secretary for Policy, Plans, and International Affairs, Department of Transportation, NTIS, December 1979.
5. These and other figures presented in this paragraph are available in *Statistics and Trends of Energy Supply, Demand, and Prices*, Energy Information Administration, U.S. Department of Energy, U.S. Government Printing Office, May 1978, pp. 39, 59, 69, 71, and 73.
6. Bureau of Labor Statistics, *Occupational Outlook Handbook*, U.S. Government Printing Office, 1978, pp. 620–21.
7. Doggette, John R., *Energy-Related Technology Programs in Community and Junior Colleges*, An Analysis of Existing and Planned Programs, Energy Research and Development Administration and American Association of Community and Junior Colleges, 1976 (ERIC ED 125-703).
8. Blair, Larry M. and John R. Doggette, "Education, Training, and Work Experiences Among Nuclear Power Plant Workers," presented at the International Symposium on Manpower Requirements and Development for Nuclear Power Programs, Saclay, France, April 1979.
9. *Ibid.*

10. Michael Finn and Wayne Stevenson, *Employment, Education, and Training Implications of the National Energy Act*, Report for Office of Education, Business, and Labor Affairs, U.S. Department of Energy, November 1979.
11. Modesto Maidique, "Solar America," in *Energy Future*, edited by Robert Stobaugh and Daniel Yergin, Random House, New York, 1979, p. 188.
12. Mason, Bert and Keith Armington, "Direct Labor Requirements for Select Solar Energy Technologies: A Review and Synthesis," working paper, Solar Energy Research Institute, August 1978, p. 24.
13. Blair, Larry M., John Craven, and Wayne Stevenson, *Community-Level Employment and Income Impacts of Biomass Energy Development and Use*, Oak Ridge Associated Universities, draft report to Oak Ridge National Laboratory, October 1979.
14. U.S. Department of Energy, *The Energy Consumer*, Office of Consumer Affairs, January 1980.
15. Science Applications, Inc., *Production Facilities for Gasohol Ethanol-A Survey*, prepared for the Fuels from Biomass Branch, U.S. Department of Energy, December 1979.
16. David J. Deutsch, "Synfuels: An Engineering Manpower Crunch Ahead," *Chemical Engineering*, January 28, 1980.

Vocational and Adult Education - Energy and the 80s

Daniel Dunham, Deputy Commissioner, U.S. Office of Education, Washington, DC

INTRODUCTION

Energy is among the top items on the new Department of Education agenda. The conservation and production of energy; the reduction of youth unemployment, especially among our nation's most seriously disadvantaged people; and a pro-active role in the fight against inflation are, taken together, some of the most critical domestic problems the new Department of Education will address in the months to come.

Many current and new people in ED will be involved in these efforts, including the Energy Education Action Center; our new Assistant Secretary for Planning and Budgeting, C. William Fischer, who comes to ED from the Department of Energy; and certainly the new Office of Vocational and Adult Education.

We are pleased and proud that our agenda includes energy, and its more effective use, conservation and production. It will receive priority attention as ED gets underway.

You have heard the energy statistics. I share them with you to emphasize not the statistics, but the fact that the consciousness of the statistics is raised with everyone, including educators. In 1970 thirty-five percent of our oil was imported; in 1980 fifty percent. The price of imported oil doubled in 1979 from thirteen to twenty-six dollars per barrel. Energy costs overall increased in the years 1978 and 1979 by 37.4 percent and it is continuing to go up. We receive 147 gallons of fuel oil at our home last week and paid 147 dollars. It is unbelievable compared to this time last year. Fuel oil has increased 62 percent in that time; electricity 11 percent; natural gas, 20 percent and gasoline, 52 percent. Household energy costs in the 50s through the 70s was about 110 dollars a month. Today it is 140 dollars. This is all compounded by the fact that we are not very good about conserving in the practice of carrying out work in the workforce, in business and industry and by individuals. We are also faced with the further confounding and compounding problem of low production of domestic sources of energy at this moment (and for the *very short* foreseeable future, hopefully). It is a domestic issue, indeed. Moreover, there are two other energy related domestic problems, unemployment and inflation. To a large extent what we do about them is pretty much voluntary. Energy is much the same. There is a clear need for long and short range resolutions to these pressing, interlocked problems. It will require the resources of every person in this country in terms of the work they do, the positions they hold, the leadership they provide and the support they offer, to solve the energy issue. It is critical, as well, to solving some of the other problems.

Education's Role

The history of education's involvement through vocational education, in this matter of energy, production and conservation is short. The 1976 Amendments to the Vocational Education Act provided for the first time a specific emphasis on energy related issues, requiring that funds be spent in two areas, at least. New and emerging occupations in energy, particularly in coal mining and technology was one of those sited in the Act. At the same time under our consumer and homemaking programs, clear emphasis was put on consumer education related to energy and improved management of resources. So there are at least two signals in the Act. The Act provides nearly $750 million dollars a year to local school districts through state agencies. There are, at least, those two clear signals and when there is one clear signal it connotes emphasis on related areas.

Prior to those amendments we did have some training programs in nuclear power production, petroleum exploration and production and, again, in coalmining technology; however these programs did not develop to the extent that we have seen other programs grow up since the Amendments, especially through our postsecondary programs. You are all aware of the Energy Education Action Center in United States Office of Education. It has done a tremendous job in providing a turnaround point for information regarding many of the issues about energy conservation and production, related instructional materials and is involved a wide array of activities such as conducting seminars and workshops.

STATE PROGRAMS

We are beginning to see in States very specific action taken to put in place personnel to deal with energy related topics in vocational education. North Carolina is one leading State, to my personal knowledge, which has in the last year and a half put on its state staff for vocational education a specialist in energy education. I know that they have projects and activities going on in a number of schools, and technical and community colleges. I have recently learned that Oregon, as well is shifting its's emphasis to energy issues in occupational programs. The American Association of Vocational Instructional Material is also focusing in on the issue of energy in their production of very high quality instructional materials in several occupational areas. We really do not know how much is happening to States. We are, at the moment, trying to get a handle on the scope and scale of that. Through our National Center for Research in Vocational Education at the Ohio State University, we will have, by June, 1980 some fix on the research and demonstration projects and the curriculum projects. It is the first year we had this kind of accountability trail on money spent under research and demonstration and curriculum under the program improvement portion of the Vocational Education Act. Our knowledge base is beginning to build. There is great activity in the States and we are all quite aware of that.

STUDENT ORGANIZATIONS

One of the particularly unique aspects of vocational education are the vocational student organizations: The Future Farmers of America, Future Homemakers of America, Distributive Education Clubs, Vocational Industrial Clubs, Health Occupations Student Organization and several others. There are now nine such organizations which are integral parts of the instructional programs. The student organizations have energy issues on their agenda. They are undertaking massive campaigns in local communities. The Future Farmers of America are particularly active as a result of a challenge that President Carter made last July when the state presidents of the FFA visited him there. He challenged them to undertake programs and activities in communities which would foster the conservation of energy. That project is underway. Thousands of Future Farmers chapters are engaged in the enterprise.

Almost concurrently with that effort there has been special interest on the part of the White House staff who deal with this topic. There is a very high degree of interest there for dealing with such ideas as how to capitalize on education strategies and systems to not only utilize student organization efforts, but, as well to effect curriculum; to begin to develop new occupational training programs; and a whole wide range of issues.

CURRENT PROJECTS

We are aware, that through our total curriculum effort over the last year some two hundred million dollars has been spent by states on energy materials development. That is a good beginning. As far as current energy related projects, there are three or four I would like to share with you. As they come to completion we will be happy to provide you results of these particular projects that are funded in part under our Programs of National Significance effort. We are now in the second year of a project to develop energy use and conservation technicians. The project is being field tested at six community colleges in various regions of the country. The purpose is to train personnel to work in locations such as businesses, industries, homes, and factories to assess and help persons in those locations find better ways of dealing with the problems of energy. This is the "Energy Use and Conservation Technicians project." The second is a new curriculum, nuclear operator trainees. This is a suggested two year post-high school curriculum which was distributed to States in 1978. There are six other major research projects on-going now, related to energy production, use or conservation of energy and the nuclear technology series which draws out of that second project I mentioned with four of its six elements completed now with two in process. Again, we should know in about 90 days or so, the extent to which similar activities are being conducted by states.

We have six curriculum development centers under a national network in vocational education also funded out of our office. In three cases with those centers, vocational energy education consortia have developed with the states who are participants in those networks and a comprehensive energy program is beginning to emerge. That is a very short litany of activities that are on the way up at the moment.

FUTURE PLANS

As far as our future plans are concerned the issues can be captured in two major efforts. Both have to do with curriculum. I do not believe that you can talk about curriculum improvement or expansion without, at the same time, talking about teacher education and the development of personnel to deal with these new enterprises. There are two aspect—two curriculum efforts which are beginning to build and will become major priorities of the Office of Vocational and Adult Education under the new department. We have concluded through some studies and research which have been undertaken over the last several months that it is not enough to focus only on the energy related technologies, that is the new and emerging energy related occupations. We must first move to modify the present curriculum in all occupational areas and re-model instructional skill training practices at the secondary school, the community college, and at other post-secondary institutions to the end that we teach energy related skills in each occupation. The notion is very simple. If you can teach people how to be more efficient and more effective in the use of energy related to the specific job that they do day to day, the savings will be tremendous. It can be done. We have taught safety, and we have taught a host of related behaviors connected to skills. We believe this can be done and much of it is already underway. This effort will be a major theme for our agenda in the 80's. In doing so we will capture the resources of State education agencies; the consortiums that develop curriculum (for example, the Mid America consortium, the Vocational/Technical Education consortium of the States, (VTE's). They can be the front runner in this modification process. The curriculum centers and network I have already mentioned will also be involved. Think too, about the notion of recertifying unemployed teachers; those who have degrees in occupations or in areas of teaching where there are no jobs. Unfortunately there are thousands such people on the streets today; many of them working in jobs requiring much less education than they happen to have. Through a very simple and straight forward effort of recertification, we could get people to work as energy training staff in classrooms, shops and laboratories in our public school system. The scope of such a program is really very significant. There are seventeen million students enrolled in vocational education today in over twelve thousand school districts and almost all twenty-two hundred community and junior colleges.

The second part of this effort centers on the new and emerging occupations in all of the areas related to energy conservation and production, such as: thermal, wind and water, nuclear, petroleum, wood and coal. What new occupations will result from new discoveries of domestics sources of energy? We have some predictability capacity with the new National Occupational Information Coordination Committee, the State Occupational Information Coordination Committee and a new array of input sources along with the Bureau of Labor Statistics and other entities. They can give us some highly valid employment projections with respect to the next ten or twenty years about these new occupations. Clearly you and I have to insist as tax payers, as persons who send our own children to some of these institutions whether they be high schools, technical colleges, or community colleges, that the programs are contemporary, with the very best possible, up to date curriculum that can be established and turned around in the shortest possible time to put people on the street with the skills necessary to engage in these new occupations. It is not enough for us to stick with the old notion of the two by four by six school curriculum for an issue that is as critical as this; (that is: two chapters a week, 4 walls to a room, 6 periods a day!) go beyond the classroom to get people from outside schools involved in a broad new way in solving this pressing problem.

Budget Policies

Finally, let me signal you at least in part of the commitment we are making to fiscal support for next year, FY '81. Our budget policy for vocational education programs of national significance will focus on four objectives. The first and at the top of the list is reducing youth employment, a related issue. Second is to increase opportunities for women, minorities and handicapped. The third is to increase incumbent worker productivity, and the fourth is to increase production and conservation of energy. To that fourth objective we are dedicating 6.1 million dollars of the 84 million available through five delivery methods. The National Occupational Information Coordinating Committee will provide us with special emphasis on energy occupation supply/demand data, career information and identification of new occupational areas.

The National Center for Research in Vocational Education will conduct applied studies, provide training and carry out dissemination and utilization activities specifically on the energy issue. The curriculum centers and network, which I have already mentioned to you, will engage in curriculum development, dissemination, and training. The teacher certification program will focus on recertifying people for new occupational areas related to energy and for energy technical training activities. Then we have a combined effort called projects, grants and contracts. We will have at least four major projects in energy, each worth up to one million dollars. Two will be in the area of technology assessment and predicting the future needs for energy related occupations and two in the area under grants will be self-initiated field study approaches. We will provide some funding in a less competitive way than we do under the contracts arrangement for materials development and installation of projects. This is an 1981 budget that will be active in 1982. It is a ways away, and I simply want to signal you that we have made this commitment. It will influence our behavior as we attempt to provide national leadership, technical assistance, and service and support of states and local communities.

Broad-Based Curriculum for Training Energy Conservation-and-Use Technicians

Michael E. Blackmon, Center for Occupational Research and Development, Waco, Texas

INTRODUCTION

To address the subject of Energy Technology is to address a very broad and complicated technical discipline. Therefore, in order to train energy technicians it was realized that it would be necessary to approach the design of an effective curriculum for this standpoint—that is, to design a broad based technical curriculum that would prepare the technician for technologies associated with the production, research and development, conservation, and utilization of the various forms of energy. Obviously, the technician must be prepared for the tasks presently required in these energy fields and most certainly will be required to learn new technical phenomena and processes as they appear on the job.

At the onset of the contract TERC-SW contacted appropriate employers and educators to determine the willingness of industry, associations, and schools to assist in the conduct of the proposed project. The response was unanimously positive and enthusiastic.

Prior to designing the Energy Conservation-and-Use Technician curriculum, the definition of the technician was needed. The first step in this definition was to identify fields in which such a technician might be employed. The four major categories of employment were identified as follows:

- Energy-related Research and Development.
- Energy Production (electric power plants, solar collections, etc.).
- Energy Utilization (factories, buildings, equipment, etc.).
- Energy Conservation (audits, construction techniques, retrofits, etc.).

Similarly, it was necessary to identify functions a technician might perform, such as the following:

- Provide direct support to engineers/scientists.

- Operate and/or maintain mechanical, electrical/electronic, electro-mechanical, or more complex equipment or systems.
- Perform building "operating engineer" services (operations and maintenance of building HVAC, electrical, and mechanical systems.)
- Perform systems-operational tests and analyses.
- Perform energy-use audits.
- Perform energy-conservation technical services: construction, retrofits, load balancing, etc.

Based on the criteria noted above, a very general definition of an Energy Conservation-and-Use Technician was formulated:

> A systems-oriented worker who possesses a combination of skills and abilities and can apply this interdisciplinary capability in jobs to develop, construct, test, operate, maintain and/or install modern equipment used in homes, businesses, institutions, factories, and other installations. Typically, this equipment consists of systems utilizing combinations of mechanical, electrical, thermal, fluidal and/or electronic computers or microprocessors.

ECUT Project Activities and Schedules

Once a general job description was established, the five essential steps of the ECUT project were formally projected into a visual pattern of operation and schedule of completion dates compacted within the three-year funding period (Figures 1 and 2). The list of steps and the intent of each are as follows:

1. *Needs Assessment*—to determine how many broad-based energy technicians will be needed over the next 10 years and the geographic distribution of these needs, to identify or structure job categories, and to delineate the training needs for preparing new employees or retraining an existing workforce.
2. *Occupational Analyses/Curriculum Design*—to determine the specific tasks the technician will be required to perform upon entering a job and the technical fundamentals he or she needs in order to understand how to accomplish present tasks and learn additional tasks as new technologies emerge.
3. *Instructional Materials Development*—to prepare relevant, modularized instructional materials that can be adapted to a variety of learning environments and curricula. Each module must be oriented toward hands-on learning and based on specific training objectives derived from the Task Inventory.

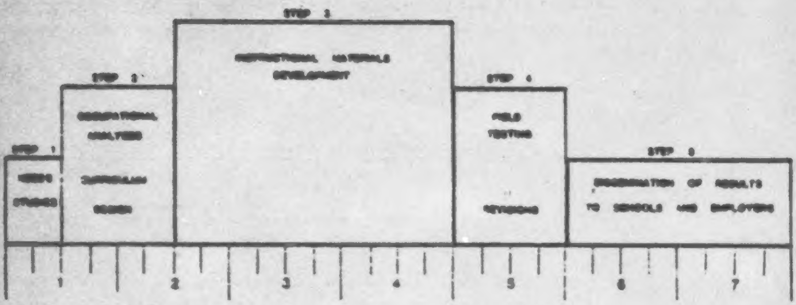

Figure 1: ECUT Funding Pattern.

4. *Field Testing/Revisions*—to validate the educational effectiveness and technical accuracy of the materials in controlled classes. This is accomplished by participating field test schools that have initiated the program and are collecting data on student performance for each educational objective.
5. *Dissemination of Results to Schools and Employers*—to assist training organizations in determining the need for the program in a local area and in designing the curriculum and securing equipment labs, faculty, student, and jobs.

NEEDS ASSESSMENT

Several related needs assessment surveys were conducted and reviewed in the first three months of the ECUT project, and a report* (Subtask 1) presenting the results of the surveys was prepared for the U.S. Office of Education. This subtask called for a national assessment of employer needs for Energy Conservation-and-Use Technicians both currently and on a projected basis, through 1988.

Although all of the surveys were informative, many were too narrow in scope or too limited for use in the assessment. Two major surveys, however, were deemed to be appropriate and applicable:

1. A national survey conducted by Dr. Kris Moore, Associate Professor of Management and Quantitative Analysis, Graduate Division, Hankamer School of Business, Baylor University, Waco, Texas.

---

* **Special Report: Subtask 1, Task A, Phase 1, Project No. 498AH80027, Curriculum for Energy Conservation-and-Use Technicians, TERC-SW Report No. 413-02A, 1-5-79.**

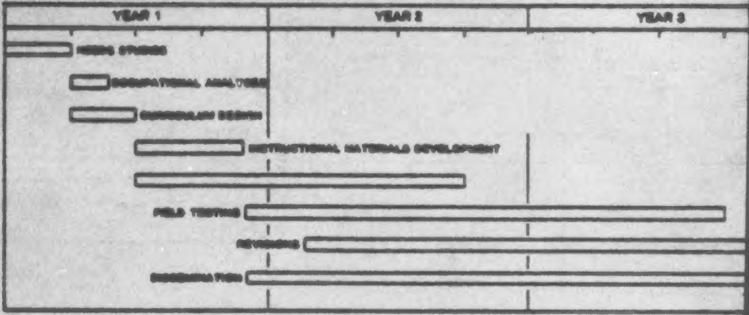

Figure 2: ECUT Project Completion Schedule.

2. Service-area surveys simultaneously conducted by eight geographically-diverse community colleges and vocational-technical schools intent upon field testing the curriculum and materials developed in the project.

Dr. Moore's survey instrument, titled "Survey of Energy Training Needs," defined the employee as one ". . . involved in planning energy use and/or applying energy conservatio methods . . ." in the following specific applications:

- Space heating.
- Water heating.
- Cooling.
- Lighting.
- Other.

This definition, though less inclusive than the definitio TERC-SW ascribed to the Energy Conservation-and-Use Technician, encompossed enough of the definition to render Dr. Moore's survey highly applicable. Indeed, it indicated a substantial need for such a technician.

Table 1 indicates an estimate of "energy technicians" employed in 1978 (the year the survey was conducted). It shows also that, according to the survey, the average annual need fo new technicians of this type is 7,392 and that the total need fo the same ten-year period is 73,924.

The needs assessment surveys conducted by the schools wer implemented within their service areas and were designed t serve two purposes. First, an assessment of the needs of employers and potential employers for Energy Conservation-and-Use Technicians within geographically-diverse areas was needed Second, the eight two-year postsecondary, schools participatin in the surveys were initially enrolled in the project to serve a field-test sites for the developed curriculum and materials—

BLE 1. Full-Time Energy Technicians.

Estimated 1978	Projected for 1983	Projected for 1988
291,394	339,106 (5-yr increase: 47,712 or 16%)	365,318 (5-yr increase: 26,212 or 7%)

significant requirement of the project. The schools needed more specific service-area data to justify the implementation of such a program.

Red Wing Area Vocational-Technical Institute, Red Wing, Minnesota, had already completed a local assessment; therefore it is not included in the following list of participating schools and survey regions:

1. *North Central Technical Institute (NCTI)*—Wisconsin, Michigan, Ohio, Illinois, Indiana.
2. *Texas State Technical Institute (TSTI)*—Texas.
3. *Miami-Dade Community College*—Florida.
4. *Albuquerque Technical-Vocational Institute (ATVI)*—New Mexico.
5. *Camden County College (CCC)*—New Jersey, Pennsylvania, Delaware, New York.
6. *Utah Technical College at Provo*—Utah, California, Arizona, Wyoming, Oregon, Colorado.
7. *Walker State College*—Alabama.

Two major survey instruments were used by the schools: a questionnaire and a cover letter. The field-test schools agreed on a common questionnaire which requested information from employers that would help schools make projections about current and future needs for systems-oriented technicians in the following areas:

- Energy use and conservation.
- Power plant or energy conversion equipment operation.
- Research and development activities.
- Maintenance of production equipment or buildings.
- Sales, distribution and/or installation of equipment or systems.

It was determined that, for the schools' planning purposes, a five-year projection was adequate. Table 2 shows the survey

TABLE 2: Needs Assessment Data (Seven Participating Schools).

Name of School	Response Rate	Estimated 1978 Employment	Projected 1983 Employment	% Increase
NCTI	6%*	780,504	822,605	5%
TSTI	12%	52,731	80,859	53%
Miami-Dade	11%	98,152	138,388	41%
ATVI	70%**	96,580	115,337	19%
CCC	12%	172,962	193,050	12%
Utah Tech	21%	413,388	644,705	56%
Walker St	26%	108,163	124,111	15%
Total			2,119,055	

data gathered from 2,412 employers which appeared to substantiate both a present and a future need for Energy Conservation-and-Use Technicians in each region and to validate the need for training programs such as those anticipated by the ECUT project.

OCCUPATIONAL ANALYSES/CURRICULUM DESIGN

During the same three-month period that it took to glean the needs assessment data, the TERC-SW staff conducted extensive research to (1) assess the status of energy-related educational programs existent in two-year postsecondary institutions, on a national basis, and (2) assess the state-of-the-art of curriculum materials used in or available to these programs. The results were printed in a Special Report* and sent to the U.S. Office of Education.

The program status assessment revealed approximately 400 schools and training entities offering "specialized" energy-intensive training (e.g., solar mechanics, energy audits, insulation, and so on). But, few programs were identified in which a comprehensive curriculum was offered, and no programs were discovered that appeared to be designed to produce an interdisciplinary technician that fulfilled the ECUT qualifications noted earlier.

It was judged that the extent to which these existing programs satisfied the employer needs quantified by the needs assessment surveys was minimal and because of the limited number of energy-related programs in existence, and their limited scopes, the impact of their graduates was also judged to be minimal. Although findings indicate that, in the next decade, employers in this country will attempt to hire more than 73,924 well trained, interdisciplinary technicians, less than 2,000 program graduates impact the labor market each year; Each of these is equipped through the indicated educational process with very narrow task performance capabilities and, often, with minimal employable skills and job knowledge.

Corresponding results were obtained in the assessment of available curriculum materials. Although so-called "energy literature" has inundated the reading public in the last few years, it appeared that virtually none of this literature had taken the form of useful texts for technical training in two-year, postsecondary schools. Our summations of the search for appropriate

---

* Special Report: Subtasks 2 and 3, Task A, Phase 1, Project No. 498AH80027, Curriculum for Energy Conservation-and-Use Technicians, TERC-SW Report No. 413-02B, 1-5-79.

"energy" curriculum materials available indicated: there are no suitably oriented, modularized curriculum materials for use in a broad-based interdisciplinary energy technology program for two-year postsecondary schools.

Based on the above information and the thrust of an ideology which centered around the definition established for the technician, the actual design of the curriculum began. For this, TERC-SW approached employers and members of a National Energy Education Advisory Committee for a list of the specific tasks such a technician might be expected to perform. In addition, the equipment, devices, or systems that might be involved in performing energy related jobs were identified.

The National Advisory Committee which has been active since the inception of the project, consists of educators and employers of technicians working in utility companies, research and development establishments, processing plants, and equipment manufacturing plants, and as operators of hotel, motel, apartment, school, and hospital facilities. Not only were members of this committee vital in providing information for the task inventory and the curriculum content, but they are continuing to critique the curriculum design and the instructional modules for technical accuracy, job relevances, and educational effectiveness.

Table 3 and 4 show the recommended curriculum that was developed for the Energy Conservation-and-Use Technician, for both the quarter and semester system. Although it is recognized that most schools will not be able to adopt the model curriculum in exactly the form in which it is presented, this model serves as a starting point for "adapting" the curriculum to the special capabilities and requirements of local educational institutions and employers of technicians.

The ECUT curriculum calls for the development of approximately 120 instructional modules. The foundation of this interdiscipinary curriculum is a full year of practical physics—Unified Technical Concepts (UTC). These technical physics modules represent a new, flexible approach to applied physics. The remaining modules, both "energy" specific and "support (core)" modules, are being developed for first and second year courses. Courses having an asterisk beside them in Tables 3 and 4 are courses that do not need to be developed, due to the availability of appropriate existing materials.

The modular approach in the design of instructional material for the ECUT project is largely due to the flexibility it affords. An adaptability to a diversity of learning environments and local

TABLE 3. ECUT Recommended Curriculum for the Quarter Systems.

First Quarter	Lec.	Lab.	Contact Hours
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technicians	3	2	5
Fundamentals of Energy Technology	3	0	3
*Technical Math I	3	0	3
Microcomputer Operations	3	3	6
	15	11	26
Second Quarter			
Unified Technical Concepts II (Physics)	3	6	9
Properties and Reactions of Inorganic Materials	3	2	5
Energy Economics	3	0	3
*Technical Math II	3	0	3
*Fundamentals of Electricity/ Electronics	3	3	6
	15	11	26
Third Quarter			
Unified Technical Concepts III (Physics)	3	6	9
Properties and Reactions of Organic Materials	3	2	5
Energy Production Systems	3	0	3
Mechanical Devices and Systems	3	3	6
	12	11	23
Fourth Quarter			
Electromechanical Devices	3	3	6
Electronic Devices and Systems	4	4	8
Electrical Power and Illumination Systems	3	3	6
*Schematic and Blueprint Reading	1	3	4
	11	13	24
Fifth Quarter			
Fluid Power Systems	3	3	6
Microcomputer Hardware	3	3	6
Heating, Ventilating and Air-Conditioning	4	4	8
Energy Conservation	3	3	6
	13	13	26
Sixth Quarter			
Technical Communications	4	0	4
Energy Audits	2	4	6
Instrumentation and Controls	3	3	6
*Codes and Regulations	3	3	6
	12	10	22

TABLE 4. ECUT Recommended Curriculum for the *Semester* System.

First Semester	Lec.	Lab.	Contact Hours
Unified Technical Concepts I (Physics)	3	6	9
Chemistry for Energy Technicians	3	2	5
*Technical Math I	2	0	2
Fundamentals of Energy Technology	2	0	2
Microcomputer Operations	3	3	6
	13	11	24
Second Semester			
Unified Technical Concepts II (Physics)	3	6	9
Properties and Reactions of Materials	3	2	5
*Technical Math II	2	0	2
Energy Production Systems	2	0	2
*Fundamentals of Electricity and Electromechanical Devices	3	4	7
	13	12	25
Third Semester			
Mechanical and Fluid Systems	3	4	7
Electrical Power and Illumination Systems	2	2	4
Electronic Devices and Systems	3	3	6
*Schematic and Blueprint Reading	1	2	3
Energy Conservation	2	2	4
	11	13	24
Fourth Semester			
*Codes and Regulations	2	2	4
Heating, Ventilating and Air-Conditioning	3	3	6
Technical Communications	3	0	3
Instrumentation and Controls	3	3	6
Energy Economics and Audits	3	3	6
	14	11	25

*Courses will not be developed -- content will be specified only.

needs was particularly important since "energy" is a rapidly changing and yet unrefined technical field. Each ECUT module contains clear and measurable learning objectives written by a technical expert and approved by representatives from industry.

FIELD TESTING/REVISIONS

As mentioned earlier, a significant requirement of the project was the selection of several geographically-diverse schools to serve as field-test sites to engage in testing and appraisal efforts to determine the relevance, suitability, and adequacy of both the curriculum and the developed/specified materials. Feedback on the field-test data will be used to evaluate the program and, to revise the curriculum and material as needed. Actual field testing of the Energy Conservation-and-Use Technicians curriculum began in the fall of 1979 when first quarter/first semester courses were implemented by participating schools.

As each module is taught, the instructors in each field-test school are evaluating module effectiveness by measuring the students' achievement against the learning objectives stated at the beginning of each module. The evaluation instruments, pretests and posttests, are constructed directly from the stated module objectives, which relate directly and specifically to the information gained from the task inventory. This approach assures content validity and has proven to be successful in several similar projects.

Student data is obtained by comparing pretest results with posttest results. Because pretests and posttests are administered by school faculty, rather than the materials developer, data is more apt to be objective. In addition to the student achievement data, observational measures also are obtained in the form of instructor comments on each module relative to the following:

- Student reactions to module content.
- Areas or topics that require inordinate amounts of clarification in class.
- Accuracy of equations, formulas, and example problems.
- Adequacy of laboratory equipment lists, procedures, and realistic experimental data.
- Student interest in the material.

Finally, all information obtained from the executon of the above steps is reviewed, evaluated, and incorporated into the revision of modules and subsequent module development.

DISSEMINATION OF RESULTS TO SCHOOLS AND EMPLOYERS

The ECUT project includes a plan for giving visibility to the curriculum and materials it fosters by conducting four two-day "Regional Diffusion Workshops" after all materials are tested and revised. The rationale for this plan is based upon successful experiences with other dissemination workshops involving educational programs in new and emerging technologies. The following conclusions were previously drawn:

- School administrators need an adequate explanation of the field and what tasks technicians are required to perform.
- Educators and employers of future graduates need to meet, face-to-face, and communicate with each other on the subject of skills required to perform required tasks.
- Employers need to indicate their future needs and describe entry level and advanced tasks that can be taught at an educational institution.
- Exemplary programs need to be described to demonstrate, by example, the feasibility and salient features of a successful instructional program, at schools, and inhouse (employee training).

Locations for the workshops will be in major cities near participating field-test sites. A tentative agenda for the workshops include a tour of the "model" energy program where attendees—administrators and faculty from postsecondary institutions; directors and planners of local, state, and federal educational agencies; representatives of employer-sponsored training organizations; etc.—can visit the labs, interview students, hear presentations by instructors, and become more familiar with the program. Objectives of the Regional Diffusion Workshops are as follows:

- To provide an awareness of the need for preparing energy-related technicians.
- To create an interest in and understanding of the curriculum and instructional materials.
- To demonstrate flexibilities in adapting the modular courses to local curriculum needs.
- To visit an existing energy technology program (one of the field-test sites).
- To encourage schools and employers to implement courses and programs for training energy technicians.

SUMMARY

This paper describes the development of a broad based, interdisciplinary curriculum designed to train an Energy Conservation-and-Use Technician.

The increased complexity of modern industry and the scope of energy-related technologies is causing a rapid change in occupational skill requirements. The technology associated with energy production, conservation, and utilization is typical of the new, complex equipment found in buildings and production lines. It typically consists of systems utilizing combinations of mechanical, electrical, thermal, fluid and/or optical components, and frequently these systems are controlled by electronic computers or microprocessors.

In view of this, a new generation of "systems-oriented" technicians is needed to develop, install, operate, maintain, and repair this type of equipment. Narrowly trained specialists are no longer sufficient or adequate for these tasks; the demand of this changing technology is for interdisciplinary technicians with combinations of technical skills and knowledge. Recent surveys indicate that at least 73,924 of these technicians will be needed in the next decade in a variety of occupations: in research and development labs as support to engineers and technicians; in power plants and factories to develop and maintain production equipment; in service organizations as energy audit technicians; in businesses, institutions, hotels and apartments for responsibilities in maintaining "plant equipment"; and in sales and installation of new, energy-related equipment such as solar heating or electric conversion systems.

Programs at postsecondary institutions for training Energy Conservation-and-Use Technicians will require a technically broad based curriculum with flexibility of modular instructional materials to allow a school to "tailor" the curriculum to local and/or regional needs. A search of schools, for energy-related programs or supporting curriculum materials of this type, has not produced evidence that either exists.

Survey data further indicates that graduates of such a program will have employment opportunities in a large number of different jobs related to energy and modern industrial equipment. Consequently, the curriculum design is based on tasks and knowledge required from several distinctly different jobs.

Schools that were selected as field-test sites for the Energy Conservation-and-Use curriculum began their instructional programs in the fall of 1979. The project is now in its second year of its three-year funded base.

PROJECT *"EFFECT"*: Energy for the Future: Education, Conservation, Training

Gail S. Dowty, Indiana University, South Bend, Indiana

INTRODUCTION

Project EFFECT was conceived from the need to address two interrelated national priorities—the growing need for a trained cadre of energy conservation technicians, and an equally important need to educate the public about the present energy situation in the United States as it relates to our finite energy resources. It became obvious to the University that a curriculum was needed for training technicians who could assist engineers and architects in assessing energy use and the potential ways of saving resources. The demand for such manpower will be even greater because of the 1978 National Energy Act, which offers incentives to administrators of schools, hospitals, and health care facilities, as well as to state and local governments and private residents, if they perform energy audits of existing facilities.

While the audit identifies energy inefficiencies and potential savings, solving the problem requires a deliberate choice by every citizen to become more energy conscious and to make necessary improvements. Historically, most consumers have made decisions to purchase heating/cooling systems, appliances, and other energy consuming devices without first-hand information about energy consumption. What is now needed is reliable, unbiased information and accessible consultive resources.

EFFECT is a three year demonstration project of curriculum development and community education in the field of energy conservation. Initiated in October, 1977, this project is funded through a special national demonstration grant by the U.S. Office of Education, Community Service and Continuing Education Branch. Conducted at Indiana University at South Bend, this is an interdisciplinary effort involving the Divisions of Arts and Sciences, General and Technical Studies, and Continuing Education.

The project was designed to meet the needs of adults throughout the North Central Indiana region by providing a model for vocational education and for delivery of specific energy conservation resources and materials. The secondary focus was on recruiting and training underemployed or unemployed adults. These persons seemed to be the most appropriate candidates because they comprise a group of representative citizens, and a training program that had worked effectively with them would probably be workable in other communities and with other groups.

Project EFFECT is unusual because it develops a curriculum concept while training participants in a new occupation. Specific innovations include:

- Developing a *new occupation* currently absent but highly appropriate to regional and national conservation needs;
- Using a wide variety of teaching methods such as videotape, media, "hands on" practicum, contact with professional practitioners, energy simulator, workshop simulation and verbal exchange to convey complex information to students *without traditional educational backgrounds*;
- Training adults with highly diverse backgrounds, but without technical training, to perform complex technical procedures;
- Combining, in one training program, modules designed to develop competencies in technical areas such as drafting and life-cycle costing and community education.

Objectives

In its effort to address the need for technically trained manpower and informed citizens, Project EFFECT developed objectives in the three basic areas of Curriculum Development, Training, and Community Education, as follows:

1. To develop a comprehensive training program for adults without previous technical training, applicable to community energy conservation needs, and adaptable to other communities and regions.
2. To create and define the new occupational role of, and to provide training for, the Energy Extension Agent (EEA), a new community resource.
3. To heighten community awareness of energy conservation.

Activities and Accomplishments

As stated, Project EFFECT is a three-year curriculum development/evaluation pilot program; years one and two have been committed to curriculum development and testing, and year three to final evaluation and dissemination. Highlights of the accomplishments that have occurred during the first two years include:

CURRICULUM DEVELOPMENT

A prototype eight-month curriculum was developed to allow both independent and integrated instruction in the competencies identified as necessary to carry out the role of an Energy Extension Agent (EAA) (See Table 1). Each module was designed to develop competencies in discrete areas; the placement of a module within the curriculum was integrated with related modules so that basic skills are developed early and modules taught concurrently have a logical relationship to one another.

At present seventeen modules have been developed in four basic content areas of classroom instruction: I. General background; II. Energy related technology; III. Energy audit preparation; and IV. Community education (See Table 2). These modules are taught in the initial six months of training. A practicum, encompassing the last two months of training, integrates what has been learned in the classroom and affords the students the opportunity of practical application of learned skills and techniques. The practicum features I. Field observations; II. Community education workshops; and III. Energy use surveys.

To help evaluate year one activities, EFFECT staff conducted a major Curriculum Evaluation Conference in November, 1978 in South Bend. The activity proved to be a uniquely valuable source of input on every aspect of the curriculum. A specialized group of participants was invited to South Bend to attend a two day intensive critique in a workshop format. Attendees were drawn from the U.S. Department of Energy and the U.S. Office of Education, from colleagues engaged in similar work in Indiana, Wisconsin, Minnesota, North Carolina, Michigan, Tennessee and Texas, and from individuals with expertise in the areas of manpower needs assessment, curriculum and energy conservation engineering-technology. From this activity, important recommendations for enriching the curriculum evolved.

The major efforts of the second project year were given over to revising and refining the curriculum and were incorporated into the Year II curriculum, resulting in some changes in the organization of the modules as well as some additions and deletions of content areas.

At the end of the second phase of instruction, the Curriculum Guides were completely revised, supplementary materials were integrated into the primary modules and the revised form of the Curriculum Guide (1979) was published in four volumes—each volume covering one major area of the curriculum.

The second major focus of Year II curriculum development was on using the original eight month curriculum as a basis for developing short-term formats for different types of target groups. Three pilot projects were developed for this purpose.

A demonstration workshop was conducted for the *South Bend Community School Corporation*. Ten maintenance and administrative personnel attended a two-day session which stressed the importance of establishing an energy management plan as well as offering an introduction to the components of an energy audit

TABLE 1: Competencies of the Energy Extension Agent

TECHNICAL SKILLS enable the student to conduct an energy use survey of a residential or light commercial structure, which includes:

- . . . a simple sketch of the structure, including plan and elevation views, showing all relevant details;
- . . . an exact accounting of heat losses and heat gains due to infiltration and conduction through floors, ceilings, windows, and walls;
- . . . an analysis of existing insulation and ventilation and recommendations regarding the need for more or less of each;
- . . . a full description of heating, cooling, hot water, lighting and appliance systems;
- . . . a two year billing audit which considers fuel consumption and cost for space heating and cooling, domestic hot water, electrical equipment and other appliance systems;
- . . . consultation with homeowners to recommend possible energy conservation opportunities, in order of priority, and the payback period of these investments.

COMMUNICATION SKILLS enable the graduate to conduct an energy conservation workshop for community, professional and lay organizations, which includes:

- . . . information on energy conservation methods (a breakdown of energy uses in the home, from largest to smallest, in terms of energy consumption and suggestions on how to cut down on usage);
- . . . displays of different types of insulation with R-values on each and recommended usage of each;
- . . . charts showing R-values on various materials and water usage in a typical home;
- . . . general information on alternate energy sources;
- . . . general discussions on energy related questions generated from the audience as a result of information presented.

including an actual "walk-through" tour of a school facility. The response to the workshop was excellent and resulted in a contract with the School Corporation to audit ten schools in South Bend and make energy-saving recommendations.

Indiana and Michigan (I & M) Electric Company sent its field representatives to a two-day workshop on residential energy auditing. Participants had the opportunity to participate in working through the Department of Energy workbook on residential audits. They also discussed how the new Federal Regulations mandating the utilities to supply energy audits might affect their own work patterns.

Pokagon State Park was the site of the first State Park audit in Indiana. Conducted at the request of the Indiana State Parks Board the audit resulted in recommendations to the park managers and staff regarding energy conservation opportunities.

The final six months of Project Effect include a last revision of the Curriculum Guides for the Training of Energy Extension Agents based partly upon suggestions made at an Energy Education Conference held in November 1979. It attracted a nation-wide clientele of 125 from the continental U.S. and Puerto Rico and included resource sharing of five exemplary projects as well as curriculum critique. The curriculum revisions are also responsive to the suggestions of students, instructors, and staff.

In addition, curriculum adaptations in the form of workshops for the Indiana State Energy Group, which train auditors of schools and public buildings have been developed and these workshops are for the purpose of certifying auditors of schools and hospitals in order for them to qualify for federal funds under the NECPA Title III grants program.

Finally, alumni of the two training classes have been assembled for an update on their placement situation and for continuing education. They were briefed as to revisions and refinements in the audit system and were asked to discuss how they have used their training on the job and where they feel the need of additional training.

Instructors, selected on the basis of recognized talent and experience in a wide variety of fields, were identified and recruited from IUSB and the greater Michiana region. Their areas of expertise ranged from the basic sciences to commercial and industrial areas such as heating and cooling, and insulation.

Guest instructors and speakers represented state and local government, as well as key professions in the industrial and commercial sectors. They included the president of the St. Joseph County chapter of ASHRAE (American Society of Heating, Guests brought their own practical and specialized perspectives to the program, and students were particularly interested in their comments about job opportunities. The curriculum's development and modification has reflected suggestions of regular instructors and guest speakers, as well as recommendations from the advisory committees and students.

Refrigeration and Air-Conditioning Engineers), the director of the Energy Conservation Division of the Building Council of Indiana, the State Building Commissioner, representatives of the U.S. Department of Energy, Office of Education, and the Indiana State Energy Group.

Advice from nonacademic persons to the instructional staff was of great importance. These contributors provided a practical, pragmatic view that effectively counterbalanced the more theoretical approach of classroom instruction. In addition, both academic and nonacademic instructors were highly responsive to feedback from students and Project staff.

TRAINING

While the main objective of Project EFFECT is to develop a new curriculum, this cannot be accomplished without the participation of pilot training classes. The first year class of 24 trainees was composed of CETA clients from Elkhart County, St. Joseph County and the City of South Bend. The trainees had considerable range in age from eighteen to fifty-four and in educational backgrounds with four holding high school GED's and nine having one or more years of post-secondary education. Weekly scheduled evaluation and critique sessions permitted the trainees to give rather immediate feedback regarding the week's materials and instruction. They understood that EFFECT was an experimental curriculum, and that they were the first to be trained in a new occupational specialty. This pioneering opportunity became a source of pressure and also of pride as they realized that their reactions and feedback were being incorporated into the evolving curriculum.

Year one trainees attended classes from December 5, 1977, through July 28, 1978, five days a week, seven hours per day. Of the 24 original students, 16 completed the first year of the program and were presented with certificates of completion. In order to receive the certificate, each student had to acquire adequate competence in each module, as well as attain "independent auditor" status during the practicum. Of those who did not finish, one found other employment and three dropped out for personal reasons. Four were terminated for cause.

TABLE 2: Core Curriculum—Didactic Instruction (6 Months)

SECTION I—General Background Module	Hours
Mathematics Review	17
Basic Writing	9.5
Energy Overview	68.5
Total	95
SECTION II—Technical Training Module	**Hours**
Basic Graphics and Blueprint Reading	89
Building Materials	20.5
Electricity	14
Alternative Energy Sources (Solar and Wood)	24.5
Introduction to Cooling Systems	23
Introduction to Heating Systems	37
Insulation and Ventilation	18
Lighting and Efficiency	20
Total	246
SECTION III—Energy Audit Preparation Module	**Hours**
Energy Cost Calculations	16.5
Energy Use Survey: Procedure and Techniques	46
Total	62.5
SECTION IV—Community Education Module	**Hours**
How to Conduct Community Energy Education Projects	97
Demography and Survey Skills	38
The Organization of State and Local Government	14
Total	149
Practicum (2 Months)	
SECTION I—Field Observations	24
SECTION II—Community Education Workshops	12
SECTION III—Energy Use Surveys	111
SECTION IV—MISCELLANEOUS—Testing, Placement	49
Total	196
Puls 6 month didactic	552.5
Complete Training Program (Core Curriculum)	748.5

The training activities of year two had three thrusts—1) intensive inservice training of employed professionals; 2) continuing education of the first year graduates; and 3) training of a second year class in the eight month Energy Extension Agent curriculum. The first of these areas has been previously discussed, however, the second is a new dimension of the project. It is an attempt to maintain contact with the first year graduates, track job performance, and assist trainees in effectively addressing evolving job requirements.

The third area of training allowed for further testing and refinement of the extended curricular prototype. The second year class was recruited from a broad range of educational backgrounds and perspectives. An attempt was made to blend CETA and non-CETA trainees for comparative purposes. Of the fifteen second year trainees, five were CETA clients; the second year class ranged in age from 18–36, eight were female and seven male, four have high school diplomas and eight have one or more years of college or related post-secondary education. Of these 15, ten completed the program and five left for personal or academic reasons.

COMMUNITY EDUCATION

The third major objective of the Project was integrated into the training curriculum. In order to teach students how to effectively deliver energy conservation information in the community, workshops, seminars, fairs, and other special activities were undertaken that would supply practical experience and knowledge. These activities were viewed as a vehicle for training and as a means to increase citizen awareness about energy utilization. Several highlights include—

"SUN DAY"—On May 3, 1978, Project EFFECT coordinated local SUN DAY observances on the campus of IUSB. Activities included demonstrations of working models of solar collectors for domestic water heating and examples of homemade solar equipment. Students from local public schools displayed solar science projects, and Project EFFECT's students were available to answer questions about the viability of solar power as an alternate energy source. EFFECT students also staffed displays illustrating various types of energy conserving materials and techniques and distributed solar and energy conservation materials to the public.

Community Workshops: During the Practicum, trainees gave workshops in the community for Project RENEW in South Bend, ACTION, INC. in South Bend, and H.O.M.E. in Elkhart, an ACTION agency. These workshops were the culmination of the students' preparation in Community Education which followed a process whereby students designed and delivered "mini-workshops" and then revised and expanded their presentation for the general public.

Energy Use Surveys (Audits): Home audits were conducted by trainees during the Practicum. The audit consisted of full analysis of the billing data for the client, as well as an analysis of the data gathered during a one to two hour on-site visit. Initially, the audits were supervised by one of the technical staff of EFFECT; eventually the trainee advanced to "independent auditor" status. The audit culminated in a report to the homeowner, complete with recommended energy conservation opportunities, listed according to payback and return on investment. The audit report also became a means for energy conservation education between the EFFECT trainee and the individual homeowner.

PLACEMENT:

Of the sixteen first-year gradutes, ten are employed in positions directly related to their training in energy technology in such organizations as the Housing Allowance Program, a County Assessor's office, ACTION, INC., an engineering consulting firm, an energy auditing firm, and an architectural firm. Two of the graduates were employed at IUSB on the Project EFFECT staff. Of the 10 second-year graduates, seven were employed in positions related to their training, with four of these on a part-time or independent basis. (Table 3)

Placement activities were an integral part of the overall project plan. These activities included instruction in basic job getting and job keeping skills, how to analyze the want ads for jobs that were not directly energy related but could develop into an energy job, resume preparation, interviewing techniques and, critique and evaluation of individual video-taped interviews.

Despite this preparation, placement was very difficult. Several factors contributing to placement problems include:

1) *The timing*—the energy crisis was just beginning to be felt in 1977-78; many people believed that it was just a hoax, and the state of Indiana did not make an immediate commitment to energy;
2) *The students*—in an experimental program which requires students to attend classes five days a week, seven hours a day, for eight months, it is understandable that few persons are in a position to make such a commitment of time and energy. Consequently, all of the students in the first class were CETA sponsored. The class was widely diversified in terms of age and educational background.

However, the greatest limitations in the first year were due to the fact that only two students out of the original twenty-four came to the Project with any interest in or awareness of energy.

TABLE 3—Placement

DIRECT ENERGY RELATED EMPLOYMENT
1 Project staff—Curriculum Materials Associate—full-time position 2nd Project year
1 Project staff—Audit Materials Specialist—hourly position—2nd Project year
2 Project staff—Audit Assistants—hourly position for 2nd year grads-(worked with Audit Materials Specialist to gather and process data for audits of S.B. schools)
1 DATA-SCAN—local energy auditing firm
1 ACTION, INC.—local weatherization program
1 Insulating Engineers—local insulation company
1 Total Environmental Consultants—local engineering firm
1 Representative for solar and wind power firms
2 Conducting independent energy audits on part-time basis
1 Concord Township Assessor's Office—Assessor
1 Conducting energy conservation workshops—independent part-time basis

INDIRECT ENERGY RELATED EMPLOYMENT
3 Housing Allowance—conducting housing inspections—agency interested in building energy component into inspections
1 Apprenticeship Programs—Construction Industry—Administrative Assistant
1 I & M Electronics—Installer

NON-ENERGY RELATED EMPLOYMENT
1 First Bank—Proof Department
1 Humaine Society—(designed plans and facilitated construction of her new home incorporating energy conservation features into the design)
1 Supervisor—Recreational Vehicle plant
1 Tutors handicapped children in Elkhart schools—working toward degree in education
1 Grocery store clerk
3 Moved out of state—unable to locate

Approximately one-thrd of the *second* class were CETA sponsored, but these CETA clients already had a strong interest in energy and they sought out the Project before checking their CETA eligibility. This pre-Project interest in energy proved to be a major ingredient when evaluating student success. Another factor that reinforces the importance of an energy pre-commitment is the fact that some students completed all modules successfully and found that when it came time to do the actual audit, they were capable of completing the process but were not interested in concentrating full-time efforts in doing nothing but energy auditing.

3) *Inability or unwillingness to relocate*: As previously mentioned, the state of Indiana came to an energy awareness slowly and the City of South Bend followed suite. All of the first class graduates wanted to stay in the area. This limited their employment options since other states had made great strides in developing their energy plans and the possibility of employment outside of Indiana appeared to be most favorable. Several students in the second year expressed an interest in relocating but never pursued this option very vigorously.
4) *Reluctance of local Utilities to accept future responsibility for participation in energy audits*—The Energy Act mandates that utilities offer free audits to their customers and that plans for implementation be submitted by summer '80. Contacts with local utilities were friendly but futile. Project EFFECT graduates were fully prepared to conduct the required audits but the local utilities have been unwilling to act before implementation plans are firm and have declared a moratorium on hiring in the meantime. Project staff has conducted an Energy Awareness workshop for the Electric company's Service Representatives and has been asked to serve on the Consumers Energy Advisory Board of the Gas company, but energy auditing training for utilities' personnel has not yet begun. All of the above factors played a crucial part in the placement outcomes to date. Follow-up activities indicate that the 26 graduates (16 First-year, 10 second-year) are employed (Table 3).

SUMMARY

The development of a training curriculum in Energy Conservation Technology—the overriding reason for Project EFFECT—was the major focus of effort. To maintain this primary focus, all the activities involved with Training and Community Impact had to be designed with the consideration, "How will this contribute to curriculum development?" Even those activities which seemed most peripheral to actual curriculum development—for example, personal counseling and readiness for job seeking—affected the ultimate production of the curriculum. The place and scheduling of activities, as well as the content and level of materials, were considered in the attempt to plan a curriculum that would be effective and usable with trainees from a wide variety of backgrounds—people with varying needs and motivation. Information dissemination and conference activities were geared toward sharing with others to learn from their comments how the curriclum could be improved. While this is a relatively long-term program, its modular organization has proven adaptable in a variety of short-term settings and this may be where it will see the most widespread use.

CONCLUSIONS

Project EFFECT was undertaken in an attempt to anticipate and meet energy workforce needs by developing and testing a curriculum and investigating manpower requirements.

It is important to assess what was learned that will be useful in designing and conducting future programs. It was found possible to train people who have little or no previous technical training to do many of the specific tasks required to perform an energy audit.

However, with the immediate need so great it is not feasible to keep people in training for six or eight months. Many of the core requirements can be learned in much less time and can be more fully developed on the job. In addition, with the RCS (Residential Conservation Service) requirements nearing implementation, it is reasonable to suppose that a great deal of training will be conducted for present employees of the utilities. With their experience they do not require some of the basic training included in the EFFECT curriculum.

A further observation is that these prospective energy auditors need some general perspective on the energy situation in order to be effective in convincing the consumers whom they meet to cooperate in conserving energy. In many or perhaps most cases, the RCS auditor will be the only utilities' representative that the consumer will ever meet. This provides the energy auditor with a golden opportunity to proselytize for energy conservation, but in order to do this he must be well-informed and able to answer the consumer's questions intelligently and credibly. For this reason, the inclusion of some interpersonal skills training for RCS auditors under the rubric of salesmanship or marketing, perhaps seems to be essential for enhancing their effectiveness.

By the end of 1980, literally thousands of auditors will be needed to implement the RCS program through the utilities. By utilizing relatively short introductory programs (4) weeks and on the job training, as well as in-service training of existing personnel the immediate need can be met. Longer programs will meet the need for managerial and supervisory personnel after initial short-term training and field experience.

Energy Education and Elementary and Secondary Schools

Shirley J. Hansen, American Association of School Administrators, Arlington, Virginia

INTRODUCTION

There is an old saying, "He who lives by the crystal ball, must learn to eat broken glass." In directing our attention to meeting energy workforce needs, we must do some crystal ball gazing; but if we aren't careful, we'll be eating our words like so much broken glass.

Education and training by their very nature are future oriented. Their constructs are built on the necessary knowledge and skills to *prepare* students for . . . something. Prepare is stressed, but the operative word is "necessary." To determine the knowledge and skills that are necessary requires that the demands be anticipated. In considering workforce needs, a look at job demands—quantity, quality, specific knowledge and skills—gives us an idea of how to groom the supply. But grooming "supplies" is not instantaneous; it takes time. Obviously, the individuals being supplied to the job market have a right to expect their education/training to be durable. Having expended time, effort and tuition to gain these skills they expect them to be marketable over time. All this requires a relatively stable supply and demand situation.

However, we are talking about an *energy* workforce. Energy needs, economics and technology are in a state of flux. Anticipating job market demands is no easy matter. For those anticipating employment in the energy field, the demand is even harder to predict. This is particularly true in areas of high technology or environmental vagaries. Obviously, we can't wait for the energy situation to settle down into a set pattern—if it ever does. We need trained, semi-skilled, skilled, knowledgeable workers in the field now. Yesterday would be better.

Use of narrowly defined job specific training fosters a rigidity inconsistent with energy's changing demands. If we are not careful, we could easily cultivate planned obsolescence in our energy workforce.

How do we avoid it? How do we minimize the retraining needs, the job dissatisfaction and the personal losses associated with finding that abilities no longer match the job that needs to be done?

A "Liberal Arts" Energy Education

There is no easy out, no pat answer. But the difficulties can be ameliorated and the workers' contributions enhanced by providing a broad energy framework to which specific jobs can be tied. In essence, what is needed is a "liberal arts" energy education.

Our task is not to train mindless robots destined to turn the third bolt on the left for the rest of their lives. We are talking about individuals who think, care and bleed a little inside when they see their job drifting away from under them. If a worker has some conception of where his job fits in the larger energy effort, he can be more adaptable within his present position, he can sense where there may be related jobs of interest to him, and he can gain more satisfaction from what he is contributing.

Let me elaborate on this last point. Whether a man is sitting at the dinner table with his wife, in the beer hall with a friend or in the conference room with a colleague, he wants to be something of an expert in his chosen field. And he wants others to know that what he is doing contributes. A basic law of the workforce jungle is everyone needs to feel superior to someone. It's up to us to help a worker feel that what he does has value. One does not have to study Herzberg, Leavitt, Maslow or any managerial psychology to know social and egoistic needs are satisfied through pride in the job and a sense of doing one's part to alleviate a national concern. Further, everyone here knows job satisfaction is not unrelated to productivity.

Today, people finally accept that a major energy dilemma exists—if for no other reason than they are constantly getting the message from their pocketbooks. With so much attention to the issue, it is even more important that energy workers be conversant in "their stock in trade." That these workers become emissaries for the cause is an added benefit.

Where and how should the liberal arts energy program be implemented? It should start in the elementary grades, expand in the secondary and become more explicit in post-secondary education. It should, where feasible, be infused into the existing curriculum content. A broad energy education will not only provide the background for the energy workforce, it will help students better understand the energy constrained society in which they must live, sensitize them to job opportunities in energy, and allow them to mentally test the water before they undertake specific training.

Basic Areas of Study

The basis of a liberal arts energy program should be cross-cutting issues that undergird all facets of energy's world of work as well as its impact on the way we live. Some basic areas of study which could be included are:

(1) *Energy's role in our economy, national security and life style*—plus a look at some options.

(2) *Fossil fuel supplies and alternatives.* This should include a look at feasibility of secondary and tertiary sources—both in financial costs and energy expended. Studies of alternatives should encourage a realistic look at potential contributions, prognosis and cost-effectiveness.

(3) *Energy relative to environmental concerns.* Even though energy is often coupled with environment, energy proponents and environmentalists are often adversaries. The trade-offs need careful objective review. Snaildarters just may not be as important as keeping warm and eating. Another example, how do we balance it out when a nation ceases to develop its nuclear energy potential (which has never cost a life) and in the same breath talks of going to war to secure an energy supply?

(4) *Forecasting energy supplies and demands.* Confusion breeds comfort for it gives people an excuse to believe what they want to believe. All of us, but especially energy workers, need to recognize why we are getting a multitude of conflicting reports. We need to understand the way forecasts are built on a battery of fluctuating assumptions and the inherent errors in such a method. Once we have a grasp of the procedures involved some of the skepticism could be allayed.

(5) *The essentials of energy management.* While this is usually thought of as a management function in the industrial sense, managing energy use applies to all of us in all our endeavors. It is the most pervasive of all the "basics" suggested.

These are some major areas to consider in planning a liberal arts energy program. While presented as cognitive efforts, the affective implications are critical as well. There is no way to overstate the importance of building the affective tie in. Changes in behavior are an essential ingredient in coping with the way energy is affecting our lives.

To illustrate how these areas of study might be implemented and extended, let's consider energy management. Not only does it permeate all our daily lives, but a closer look helps to underscore the need for workers in the field to have a better idea of the energy effects of all their actions. Further, energy management as a category depicts one of the most predictable of job market demands.

Choosing this very basic area of study also provides an opportunity to issue a plea to all and sundry to remove the mystical jargon barriers. One does not need an engineering degree to understand the common sense principles of thermodynamics. Heat runs down hill. Energy management in a building is controlling that flow or adjusting air conditions to compensate for that which we don't control.

Student Participation

Recently the Michigan Energy Extension service completed a study that should reassure us all. They found the most effective way to teach energy conservation (or management) is through participation. Sounds rather reminiscent of John Dewey's "learn by doing" philosophy, doesn't it? So we are not sailing uncharted waters. We need to find something for students to DO. And there certainly is plenty to do in those energy sieves we call school buildings.

Once the rudiments of thermodynamics and systems appropriate to the age level have been covered, the simplest of items—doors, windows, shades, lights, progressing to thermostats and unit ventilators—can all be monitored right in the classroom. There are also opportunities for increasing sophistication in some of these items. Take lighting for example. A light meter is a great tool. It helps convey that simply turning off lights is not the answer. We need certain lighting levels for learning, safety, etc. The essence of conservation is using the necessary energy as efficiently as possible. Students need to be able to distinguish between conservation and curtailment. Logically, this also leads to helping students understand that lighting sources vary in their energy efficiency; i.e., lumens per watt. For example, fluorescent is more efficient than incandescent lighting. One caution: because lights are so visible thay are a natural focus of energy instruction, but keep in mind the relative energy demand for the building's lighting. Cutting lighting by 10 percent seldom reduces the overall demand more than 1 percent.

Conservation Education—Reinforcement

Moving beyond the classroom, the school building itself is a great laboratory. Student energy audits like the one developed by Tenneco are natural extensions of earlier classroom efforts.

There is no better time for students to learn about energy than when the very walls around them are being modified to conserve energy. This is a tremendous opportunity for circular reinforcement. The students in their quest assist in the district efforts but also seek answers that require all the staff to know what's going on and be involved.

People involvement is at least half of a sound energy program—hardware changes alone are not enough. The old saw about practicing what we preach was never more timely or appropriate.

A strong education/training component for all the district staff is critical. They cannot teach, or preach, or practice if they do not know what they are about. The building custodian is probably the most important recipient of such training. In our Saving Schoolhouse Energy project we came across a very dedicated custodian who had for years faithfully flipped a switch each afternoon and morning as he had been told. Unfortunately, no one had told him why. The switch was a manual night setback. As close as our engineers could determine the switch had not been connected for 12 years. The ventilation and heating had been running at full bore 24 hours a day, winter and summer. An informed custodian would have known things were not right. Aside from the maintenance aspects, it's well to remember that some of our best school counselors are custodians. They are apt to take one or two students under their wing and explain the intricacies of some energy matter. What an exciting beneficial time for all should a class visit the boiler room to have the custodian explain how it all works.

But education goes beyond the school doors. Energy education should logically extend into the community. If appropriate attention is paid to potential liability concerns, student energy audits of public and commercial buildings are excellent ways to apply the students' knowledge and raise community awareness.

SUMMARY

The schools, then, are a natural to start laying the energy groundwork for the more specialized training to come. School people of this country know a lot about conserving energy. The record shows the public schools have reduced energy consumption by 35 percent since 1973. They can and must "preach what they practice." Inside or outside the building, the best grounding for the training of an effective energy workforce starts in the elementary and secondary schools with a broad liberal arts framework.

Edward R. Murrow once said, "Everyone is a prisoner of his own experience." If we only train people in a narrowly defined area for a specific job, we place bars around his opportunities. He is chained to the job. Energy conditions and technology are changing so rapidly we owe it to this emerging workforce to provide them with the greatest flexibility possible. An energy "liberal arts" program will extend their experience horizons and give them freedom of choice in the job market.

It is a loss of human potential, needed energy assistance and personal satisfaction to do less.

Energy and Jobs for the Future

Rafael Fermoselle, Energy Project Director, American Vocational Association, Arlington, Virginia

INTRODUCTION

In order to meet the nation's increasing energy needs in the future, we will be relying on a broad range of energy sources. This range must encompass *all* sources from the traditional fossil fuels such as oil, gas and coal to new fuels derived from oil shale and tar sands. It must include nuclear energy and the new technologies to use renewable energy sources such as the sun, the wind, the ocean, and biomass. Methods of conservation, greater efficiency in the use of energy, and the new technologies to use this broad range of energy sources will have to be developed and put into wide use throughout the United States.

In the next few years every region of the country will experience the occupational impact of the nation's need to increase energy production. As our supplies of traditional energy resources such as oil and gas dwindle, energy production must utilize diverse technologies to reach the maximum efficiency in utilizing our supplies. The occupational impact of the nation's energy policies, however, will be different in every state and every region of the country because our energy resources are not evenly spread throughout the nation.

This paper will discuss the occupational areas that may experience growth as a result of the development of a blend of different energy resources, the regions where the jobs may develop, and the need to establish a well-coordinated plan to train skilled workers through vocational education programs. We will also point out the information requirements for such a plan, and AVA's efforts to draft a comprehensive plan.

Oil and Gas

In states where oil and gas are produced, increased drilling and exploration as well as the use of more advanced methods for enhanced recovery will generate new jobs for workers with the knowledge and skills in these new technologies. According to the U.S. Department of Labor, employment in the oil and gas industry rose by 33% between 1970 and 1976 and is expected *to rise by another 70% by 1985.* Most of the growth will take place in the producing states, such as Texas, Louisiana, Oklahoma, California, Wyoming, Kansas, New Mexico, Colorado, Ohio and Alaska.

Jobs traditionally needed in the oil and gas industry include scouts, drafters, rig builders, tool pushers, rig engine operators, gaugers, gas plant operators, cementers, and computer operators. All of these skills fall within the purview of vocational education.

In addition, several states will be affected by the need to improve the transportation system to take oil and gas from where they are produced in the West and Alaska to where they are needed in the large population centers in the East. For example, the Four Corners Pipeline is the only pipeline as of January, 1980 that can be used to transport oil from Alaska and California to the East. (From Long Beach to New Mexico and Texas.) Additional pipelines to transport natural gas from Alaska to the lower forty-eight states will also have to be built through several states. (Figure 1.) Thus, jobs for workers with specific skills in energy transportation systems including welders, pipe fitters and engineers, will be created.

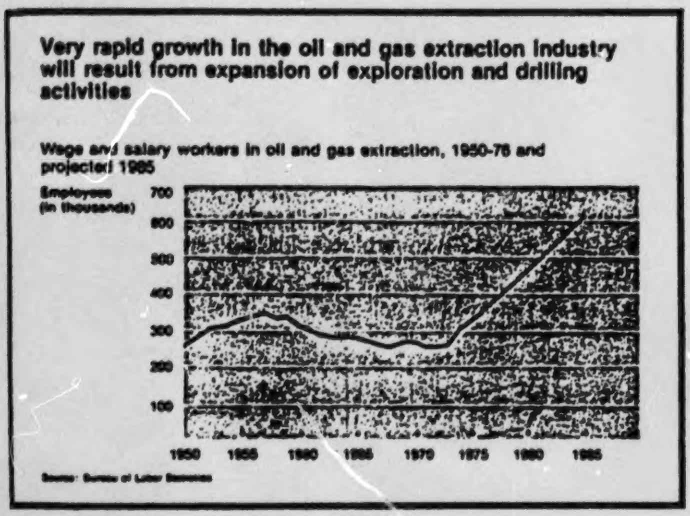

Figure 1

Synthetic Fuels

The technologies for producing synthetic fuels from coal on a commercial scale have existed for some time and have been used in other countries such as Germany and South Africa, for more than forty years. New technologies to produce synfuels from coal in commercial quantities and for reasonable prices will need to be developed to meet the nation's needs.

It may take more than ten years before facilities are funded and constructed and new fuels begin to flow to the consumers. However, workers with skills in the technologies will be needed soon to work in the research and development efforts and to build the new plants and the transportation systems. Large scale efforts to develop improved liquefaction and gasification technologies are already being funded by the U.S. Department of Energy as well as the private sector and additional funding is being considered by the U.S. Congress. For example, DOE scientists are conducting an $800,000 project in the 570 square-mile Centralia-Chehalis Coal District in west-central Washington State to test the commercial feasibility of underground coal gasification. Similar experiments are also being conducted at the Hoe Creek, near Gillette, Wyoming and in other parts of the country.

Millions of barrels of oil are trapped in tar sands and oil shale formations in several Western states. Shale oil is probably closer to commercial production than any other sources of synthetic fuels that are now under study. In order to develop these resources, workers and technicians with skills in the production technologies, environmental safety systems, and the operation of new equipment for mining and transporting these new synfuels will be needed in the future in states like Utah, Colorado, New Mexico, and Wyoming where these energy sources are found. Other technicians and skilled workers will be needed in the states through which new pipelines or other transportation systems will pass as the fuels move to reach our population centers.

Renewable Energy

Another source of fuels for the future are those that can be produced from crops and agricultural biproducts. They are called "biomass." They are expected to make a significant impact in several states in the next few years. According to some estimates, gasohol, a combination of ethyl alcohol (ethanol) and gasoline, may be commercially available in large quantities as early as 1985. One firm in Decatur, Illinois, is already producing approximately 60,000 gallons per day of alcohol from corn. Several other firms acoss he country produce alcohol for use as gasohol, and the number may increase substantially in 1980 as a result of the President's effort to turn surplus grains into a new source of energy. The development of this fuel will have a substantial impact on rural areas where workers with skills in these technologies will be needed.

Other biomass projects include the use of municipal wastes to fuel electric utilities and for other energy uses. For example, in Bridgeport, Connecticut, as well as other cities, garbage is being used to fuel electric power plants at competitive costs with other traditional fuels. In Los Angeles, in mid November 1979, a municipal utility began to use landfill methane gas to generate electricity. This gas recovery project will save the country approximately 83,000 barrels of imported fuel annually. Again, workers with skills that can be used to implement these new technologies will be needed across the country.

Solar energy systems will also play an important part in the solution of our future energy needs. Several solar technologies are now under study, and several solar energy systems are already available at competitive prices for consumers. Solar technologies include: passive solar systems, active solar heating, cooling and hot water heating, solar thermal power systems and photovoltaic systems.

Fuels from biomass mentioned above are also considered as part of solar technology because they are derived from energy from the sun which is captured and stored by plants through the process of photosynthesis and released when they are burned. Wind energy is also the result of the action of the sun as it heats the earth's atmosphere. The same is also true for energy that can be derived from ocean currents and temperature differences between surface water and deep water.

Solar technologies are, for the most part, very labor intensive. This means that thousands of workers will be needed to build, install and maintain these systems as they become commercialized in the future. However, it may take several years before demand for workers in solar energy develops. In addition, the skills required will be, for the most part, in traditional job categories, such as carpenters, plumbers, pipe fitters, welders, etc. Even at the idealistic goal of close to 2.5 million new installations of solar hot water and cooling and heating systems per year by 1980, less than 10,000 workers would be needed nationwide. Installations in 1978 and 1979 fell far short of the more modest goals of 282,000 in 1978 and 350,000 in 1979. Less than 140,000 units have been installed nationwide. The number of workers currently employed in solar energy technologies is probable less than 6,000.

Other alternative energy sources, i.e., geothermal power, hydroelectric and hydrogen power systems are under study and many are already in operation. For example, the Department of Energy recently guaranteed a $29 million loan from the Bank of America for exploration and development of geothermal energy in the Tuperial Valley of California. The plan calls for drilling 19 wells to provide geothermal energy for a 55 megawatt electric power plant. Congress has authorized $300 million in loan guarantees for similar projects across the country.

Coal

Although we are developing many new sources of energy, the energy source that is probably our most promising, if only for its abundance in the nation, is coal. Coal represents a wide range of possibilities for meeting our industrial, residential and commercial energy needs. Coal could replace all the oil and natural gas used in electric power generating plants, or it could be converted into acceptable forms of liquid fuel, gas, and cleaner burning solid fuels. But in order to increase our use of coal without causing environmental problems, new technologies will have to be designed, new equipment built, and a transportation network designed and built.

Thirty-seven states where coal resources exist will probably experience an increase in mining operations in the future in addition to the increased production experienced since 1973. The National Coal Association forecasts that coal production in 1980 will reach a record 776 million tons, with most of the increase production in mines west of the Mississippi River. The U.S. Labor Department expects the number of workers employed in mining to rise by 39% between 1976 and 1985.

The increase in coal production should be sustained because the *Power Plant and Industrial Fuel Use Act of 1978,* which is part of our *National Energy Plan,* prohibits the use of oil or natural gas in new electric utility generation facilities or in new industrial boilers. The Act also forces plants with the capibility for burning coal to return to coal use if they had converted to oil or gas as a fuel in the early 1970's. When this is translated to hundreds of power plants across the nation that are now burning oil or gas, it is obvious that many skilled workers will be needed not only to mine but also to build and maintain the network to feed the power plants throughout the country.

Employment in many states will also be affected because a new system needs to be built to transport the coal from the point of production to its final users. For example, a recent study conducted for the Energy Information Administration revealed that in order to supply a power plant in the Boston area with enough coal to generate the electricity requirements of that region, approximately 1,500 rail cars would be needed. The cars would have to be built and maintained and new improved railroad beds would be required.

Conservation

Despite the technological advances, the development and use of very diverse sources of energy conservation and increased efficiencies will probably be our cheapest way to meet our nation's energy demand. Current conservation programs include the development of:

- surface passenger mass transportation systems that are more efficient than private automobiles;
- lighter weight trucks, buses and automobiles with more efficient engines;
- new advanced burners and boilers for industry;
- better building designs;
- better insulation materials and energy management systems.

These energy efficient technologies will require the retraining of workers for their installation, operation, and maintenance. Training programs must provide an adequate labor force to perform these tasks. Private industry is already training workers with skills necessary for these new technologies. For example, General Motors is involved in training hundreds of mechanics to repair and service diesel engines for their new more fuel efficient autos. They are also working closely with textbook publishers and vocational educators to establish new and updated educational programs. Under the CETA program and through efforts of the Community Service Administration and the Department of Energy, young out-of-work youth are being trained to insulate homes. Many other similar programs have also been set up throughout the country with mixed results.

The need to implement energy saving programs is real as well as the need for trained workers. However, before school systems rush to create programs to train "conservation specialists," careful preliminary needs/assessment studies need to be carried out to find out if in fact there will be a need for workers with those skills. In the rush to do something some schools have found that their graduates cannot find employment with these new skills.

Nuclear Energy

According to the U.S. Department of Labor, as of 1976, 183,000 workers were employed by the nuclear energy industry in the United States. They included truck drivers, bulldozer operators, skilled machinery repairers, radiation monitors, pipe fitters, carpenters and electricians. For the most part they need special training and certification to work in the mining and processing of uranium and the construction and operation of nuclear plants. Approximately 71 nuclear plants are in operation, over 50 more power plants are under construction, and many more are planned. However, future growth will depend on safety and government support. Employment at nuclear power plants, nevertheless, is expected to rise in the future, and the number of safety monitors will probably experience a substantial increase due to the Three Mile Island incident.

Administration

In some parts of the country the demand for many different types of white and blue collar workers for energy related industries and for government agencies at the local, state and federal level is already developing. For example, in the Washington, D.C. and Denver areas, there is a substantial demand for technicians in different energy related areas such as computer programmers, energy information specialists, engineers, physicists, clerks, secretaries, and many other professions required to support the administration of energy related research and development programs and regulatory and law enforcement programs. In locations where thousands of new jobs in coal mining and other energy related industries have developed in some Western states, other jobs have been created to house, feed, clothe, and provide other services to these workers.

Vocational Education's Role

Vocational and adult education is particularly suited to make a substantial contribution to the nation's energy goals by preparing skilled workers for occupations in the emerging energy technologies. Vocational education's goals have traditionally been to meet the manpower needs of the nation and to equip the individual with skills to serve society and live in a changing world. The energy crisis will require some significant changes in vocational education programs and in the national job training picture to adapt to the current problem facing the nation.

A general agreement is that the demand for skilled workers presented in this article will materialize in the next ten years. However, some serious questions must be raised before vocational education programs are updated to produce skilled workers for the emerging energy technologies. We need to know *when* the demand will occur, *where*, and *how many*. Programs to train workers will have to be *tailor-made* to each region of the country *depending on the energy resources available*. Teacher training programs and in-service programs for teachers will have to be designed. New curriculums for training workers for new technologies will have to be prepared in some cases, in others, updating of existing curriculums will be sufficient. Before these decisions are made, a careful and coordinated needs-assessment program must be designed and funded in order to maximize results and avoid making costly mistakes that may hamper our efforts to solve the nation's energy problem.

AVA Energy Awareness Project

The American Vocational Association is working with multiple cooperating agencies, institutions, educators, and the U.S. Department of Energy to make vocational educators cognizant of the national energy situation, their role in relation to that situation, and in the preparation of a plan to enhance their effectiveness to meet the national energy goals.

The plan will take into consideration the diverse regional circumstances outlined in this paper and the need to define the specific needs of every region.

The project is bringing together vocational educators, government officials, and industry representatives from across the country to exchange ideas and coordinate their resources to generate a national plan. These representatives will return to their states and conduct energy workshops with vocational educators from comprehensive secondary schools, area vocational-technical schools and community colleges. They will assess current energy related activities within vocational education; define desired activities to take place; and design strategies to move vocational education from "where we are" to "where we should be" in the future. The findings and suggestions made at the regional level will then be brought together for the national plan.

Through these combined efforts, the Department of Energy and AVA together will be able to move toward the mutual mission of meeting the nation's need for workers skilled in the occupations required to meet the nation's energy goals.

Training Technician for Coal-Fired Power Plants

Bonnie F. Rinard and Daniel M. Hull, Center for Occupational Research and Development, Waco, Texas

INTRODUCTION

Electric utilities in the United States currently are operating 1705 generating units, using coal or lignite as the primary fuel. The distribution of these units by state and DOE region are given in Figure 1. An additional 289 units are planned or under construction and will be operational in this decade. The efficient, economical, safe operation of all these units requires a significant increase in the size and competency of the technical, operating workforce. As plants become larger and more complex and as more equipment is required to control the impact of combustion by-products on the environment, the need for a larger, better trained workforce will become even more apparent.

Some of the larger utilities already have begun in-house training programs; others are hoping that two-year, postsecondary institutions (technical institutes and community colleges) will initiate programs to prepare future employees. It is anticipated that both types of training activities (employer and public schools) will increase significantly in the next several years. A coordinated nationwide effort is under way to: 1) quantify the needs according to job category; 2) design model training programs; 3) identify and/or develop appropriate instructional materials, and 4) assist utilities and schools in adapting the curriculum models to local needs and in implementing the training programs. Examples of similar developments of national model training programs in emerging or changing technologies have proved that a single, cooperative effort can save time and money be eliminating the hundreds of duplicative efforts that otherwise will, inevitably, take place.

Project History

On July 1, 1978, Technical Education Research Center-Southwest* (TERC-SW) began the first phase of a multiphase educational research, development, demonstration and dissemination project sponsored by the Electric Power Research Institute (EPRI). A project advisory committee consisting of twelve utility representatives, three school administrators and four other persons was selected to meet periodically throughout the project to review the project performance and to recommend change.

---

*In a reorganization of Technical Education Research Center in December, 1979, the Southwest Center (TERC-SW) emerged as a separate, affiliated, non-profit corporation under the title Center for Occupational Research and Development (CORD).

The purpose of this first phase was to determine job categories composing technical workforce, tasks performed by each group and number of technicians needed through 1990. Through the use of surveys of 409 power plants and personal visits by TERC-SW staff to additional power plants, the following seven job categories were identified: operator, electrician, mechanic, fuel handler, environmental and chemical analysis technician, instrumentation and control technician, and technical services technician. Titles for these positions vary from plant to plant; the most common titles for each category are given in the functional organization chart in Figure 2. This organizational structure is not universal, but the jobs are common throughout the industry.

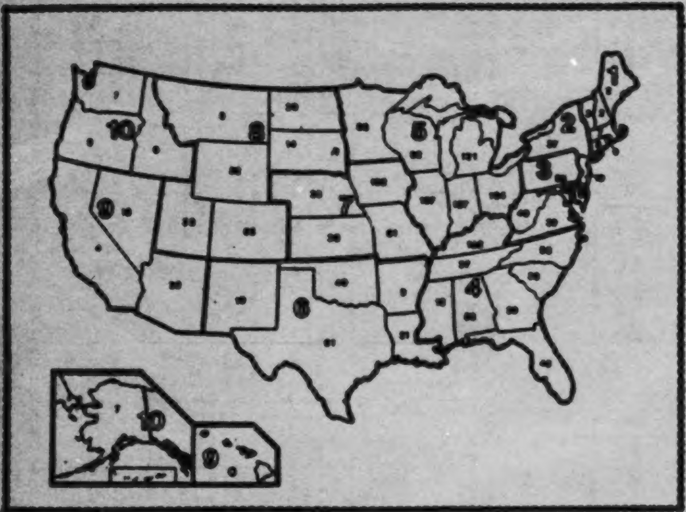

Figure 1: Coal-Fired Units Location by State and Department of Energy Regions.

The same surveys which identified job categories also established the needs of the utilities for each job category through the year 1990. The actual number of new hires needed each year

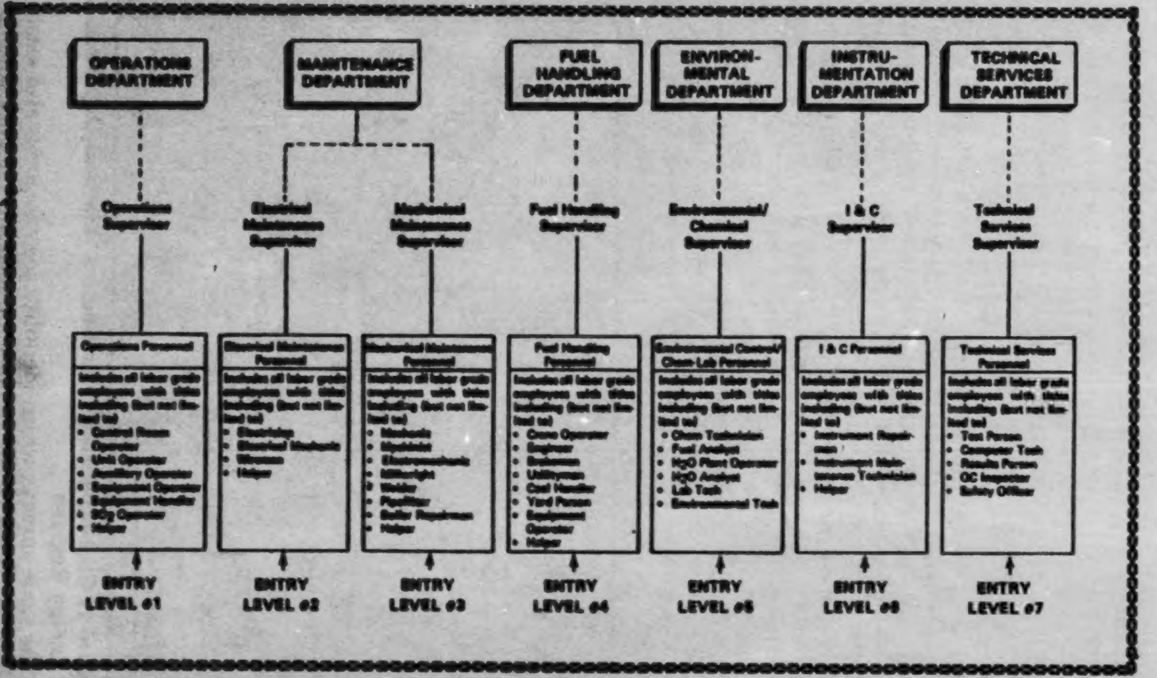
OPERATIONS DEPARTMENT
MAINTENANCE DEPARTMENT
FUEL HANDLING DEPARTMENT
ENVIRON-MENTAL DEPARTMENT
INSTRU-MENTATION DEPARTMENT
TECHNICAL SERVICES DEPARTMENT
Operations Supervisor
Electrical Maintenance Supervisor
Mechanical Maintenance Supervisor
Fuel Handling Supervisor
Environmental/Chemical Supervisor
I & C Supervisor
Technical Services Supervisor
Operations Personnel
Includes all labor grade employees with titles including (but not limited to)
• Control Room Operator
• Unit Operator
• Auxiliary Operator
• Equipment Operator
• Equipment Handler
• SO₂ Operator
• Helper
Electrical Maintenance Personnel
Includes all labor grade employees with titles including (but not limited to)
• Electrician
• Electrical Mechanic
• Wireman
• Helper
Mechanical Maintenance Personnel
Includes all labor grade employees with titles including (but not limited to)
• Mechanic
• Machinist
• Electromechanic
• Millwright
• Welder
• Pipefitter
• Boiler Repairman
• Helper
Fuel Handling Personnel
Includes all labor grade employees with titles including (but not limited to)
• Crane Operator
• Engineer
• Brakeman
• Utilityman
• Coal Handler
• Yard Person
• Equipment Operator
• Helper
Environmental Control/Chem Lab Personnel
Includes all labor grade employees with titles including (but not limited to)
• Chem Technician
• Fuel Analyst
• H₂O Plant Operator
• H₂O Analyst
• Lab Tech
• Environmental Tech
I & C Personnel
Includes all labor grade employees with titles including (but not limited to)
• Instrument Repairman
• Instrument Maintenance Technician
• Helper
Technical Services Personnel
Includes all labor grade employees with titles including (but not limited to)
• Test Person
• Computer Tech
• Results Person
• QC Inspector
• Safety Officer
ENTRY LEVEL #1
ENTRY LEVEL #2
ENTRY LEVEL #3
ENTRY LEVEL #4
ENTRY LEVEL #5
ENTRY LEVEL #6
ENTRY LEVEL #7

Figure 2: Functional Organizations and Job Categories within a Coal-Fired Power Plant.

in each job category is projected in Figure 3. The last column gives the total number of new employees needed by 1990.

Detailed task inventories were developed for three of the categories noted above: 1) Plant Operator, 2) Environmental and Chemical Analysis Technician, and 3) Instrumentation and Control Technician. The choice of these categories was based on demonstrated need, staff recommendations and, especially, the counsel of the Project Advisory Committee. These task inventories provided the bases for detailed curriculum design (Phase II) for the corresponding power plant job categories. The curriculum design work resulted in three Curriculum Planning Guides. Each Guide contains the following elements:

- Summary of employee needs for job category.
- Job description for job category, including detailed task inventory.
- Course flow chart.
- Course descriptions and module outlines.

The purpose of the curriculum planning guides is to provide national models for training Power Plant Operators (PPO), Environmental and Chemical Analysis Technicians (ECAT), and Instrumentation and Control Technicians (ICT) to work in coal-fired power plants. It is not intended that the suggested curricula be rigid but that they provide the framework for adaption to suit local needs. The curricula reflect the consensus of requirements from representatives of various power plants and postsecondary, vocational-technical institutions across the country.

Technician Programs

The ECAT and ICT curricula (see Tables 1 and 2) were designed for use as two-year, postsecondary technical programs to prepare technicians for entry-level jobs at electrical power plants. The curricula also should provide the graduates with sufficient background that, with a reasonable amount of work experience, they may advance to positions with increasing responsibilities. In order to accomplish this, the ECAT and ICT curricula should accomplish the following three objectives:

1. To teach students those techniques and skills that they will be required to perform on the job.
2. To provide sufficient depth in technical principles related to the equipment and systems in power plant operation so they may quickly learn additional skills and knowledge to meet changing job requirements or to qualify them for promotion to a higher level position.

JOB TITLE	New Employees Needed Per Year												
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Operator	2301	2346	2350	2384	2401	2426	2452	2478	2505	2532	2543	2586	31,611
Electrician	570	576	582	588	594	601	607	613	620	627	633	640	7,775
Mechanic	1935	1956	1976	1997	2019	2040	2062	2084	2106	2128	2151	2174	26,543
Fuel Handler	1016	1025	1038	1049	1060	1072	1083	1094	1107	1219	1131	1143	14,045
Environmental & Chemical Analysis Technician	209	211	213	216	218	220	222	225	227	230	232	235	2,863
Instrumentation & Control Technician	427	432	437	442	447	451	456	461	467	472	477	482	5,874
Technical Services Technician	541	547	555	560	567	573	580	587	594	601	608	615	7,463

Figure 3: Projected Yearly Needs for New Employees (to Accommodate Growth and Attrition) in Coal- and Lignite-Fired Electrical Power Plants.

3. To provide the students with a broad knowledge of the entire power plant system operation and communication skills so they can relate the details and functions of their job to other equipment and personnel throughout the plant.

TABLE 1: Environmental and Chemical Analysis Technician

Table 1 shows the recommended sequence of courses for a two-year curriculum. The quarter system is used assuming 10 full weeks of class and laboratory activities.

Course	Class Hours	Lab Hours	Contact Hours
First Quarter			
Introduction to Environmental and Chemical Technology	2	0	2
Environmental Chemistry I	3	6	9
Technical Math I	3	3*	6
Unified Technical Concepts I	3	3	6
Technical Communications I	3	0	3
	14	12	26
Second Quarter			
Power Plant Fundamentals and Systems I	4	3	7
Environmental Chemistry II	3	5	8
Unified Technical Concepts II	3	2	5
Gravimetric and Volumetric Analysis	3	6	9
	13	16	29
Third Quarter			
Properties and Reactions of Organic Materials	3	6	9
Technical Math II	3	3*	6
Fundamentals of Electricity/Electronics	3	5	8
Unified Technical Concepts III	3	3	6
	12	17	29
Fourth Quarter			
Power Plant Fundamentals and Systems II	3	3	6
Environmental Biology	3	3	6
Instrumental Analysis I	3	6	9
Technical Communications II	3	0	3
Blueprint and Schematic Reading	1	3	4
	13	15	28
Fifth Quarter			
Power Plant Chemistry	5	6	11
Environmental Analysis	3	6	9
Plant and Laboratory Safety	3	3	6
Elective	3	0	3
	14	15	29
Sixth Quarter			
Pollution Control for Solid-Fueled Power Plants	3	2	5
Water Treatment	3	6	9
Instrumental Analysis II	3	6	9
Elective	3	0	3
	12	14	26

*Technical Calculations

Both the ECAT and ICT curricula consist of technical and support courses. The technical subjects are specifically designed to achieve the goals listed, whereas, the support courses are taught to provide students with the required background for the technical courses. These curricula also include two electives.

The project advisory committee has recommended that these electives be chosen from courses in human relations, sociology or economics. The first two areas, sociology and human relations, would best prepare students for situations where they must work closely with other power plant employees in order to ensure efficient plant operation. An economics course would show these future technicians in "dollar and cents" terms the benefits of an efficient plant. Electives also would provide flexibility for schools to add additional courses needed by local industry or courses required to meet state or regional accreditation requirements.

TABLE 2: Instrumentation and Control Technician

Table 2 shows the recommended sequence of courses for a two-year curriculum. The quarter system is used assuming 10 full weeks of class and laboratory activities.

	Lecture	Lab	Contact Hours
First Quarter			
Fundamentals of Instrumentation and Control	2	0	2
Unified Technical Concepts I	3	6	9
Technical Math I	3	3	6
Chemistry for Instrumentation and Control Technicians	3	2	5
Electrical and Mechanical Fabrications	1	3	4
	12	14	26
Second Quarter			
Unified Technical Concepts II	3	6	9
Technical Math II	3	3	6
Fundamentals of Electricity/Electronics	3	5	8
Microcomputer Operations	3	3	6
	12	17	29
Third Quarter			
Unified Technical Concepts III	3	6	9
Electronic Devices and Systems I	3	5	8
Electromechanical Devices	3	2	5
Power Plant Fundamentals and Systems	5	2	7
	14	15	29
Fourth Quarter			
Technical Communications I	3	0	3
Mechanical and Fluid Devices	3	2	5
Control Systems I	3	6	9
Electronic Devices and Systems II	3	6	9
Elective	3	0	3
	15	14	29
Fifth Quarter			
Calibration and Standardization	1	4	5
Control Systems II	4	6	10
Microcomputer Hardware	3	3	6
Technical Communications II	3	0	3
Schematic and Blueprint Reading	2	3	5
	13	16	29
Sixth Quarter			
Instrumentation and Control Systems - Power Plant Applications	3	6	9
Plant and Lab Safety	3	3	6
Electronic Troubleshooting and Repair	2	4	6
Electronic and Display Devices	2	3	5
Elective	3	0	3
	13	16	29

These programs are not intended to make graduates proficient in every task they will have to perform in the power plant. Each power plant will have to provide "plant specific" training. Also, proficiency in work comes only with practice and experience. It is impossible to forecast the exact requirements of any individual or to predict changing technology. The material in the curriculum planning guides is only that—a guide. Institutions adopting one of these curricula should work closely with utilities to ensure that the program will produce qualified technicians with the skills and knowledge most needed in the industry.

Power Plant Operators

The curriculum for training power plant operators differs from the ECAT and ICT programs because it is designed primarily for use in-house. (Table 3) Traditionally, when new operators are hired to work in a power plant, they receive one day to two weeks of orientation before they are allowed on-the-job. This orientation includes such things as introduction of supervisors, delineation of job responsibilities, description of employee benefits, and instruction in power plant basics and plant safety. Structured training in many plants ends here, and the employee has to learn on-the-job the skills and theory needed to perform various operator tasks. Other plants have varying degrees of further training, ranging from self-study programs to classroom lectures with laboratory demonstrations. This training usually is scattered throughout the employees' training as they progress through the ranks.

To provide flexibility for use in employer programs, the curriculum consists of individual modules related to specific tasks or plant equipment and various technical courses.

The curriculum planning guide is based on the following suppositions

- There are three basic levels of operator training after orientation:
  Level 1—Entry Level Operator.
  Level 2—Intermediate Grade Operator.
  Level 3—Control Room Operator.
  (These levels [as well as job titles] will vary from plant to plant.)
- A student should complete all of the courses and modules specified at each level before having to use this knowledge on the job.

TABLE 3: Power Plant Operator

The Operator Curriculum listed in Table 3 is designed for use in employer training programs. It is arranged in levels which are taught as the new employee progresses through the ranks to control room operator.

ORIENTATION

Course Titles

- Power Plant Fundamentals and Systems
- Plant and Laboratory Safety

LEVEL I

Course Titles

- Fundamentals of Electricity and Electronics
- Technical Math I
- Print Reading
- Hand and Power Tools
- Unified Technical Concepts I, II, and III

Module Titles

- Fuel-Oil Unloaders
- Pyrite Removal Equipment
- Coal and Fuel-Oil Burners and Ignitors
- Ash System
- Lubricants and Lubrication
- Indicating Devices
- Seal-Oil System
- Sootblowers, Lances and Rods
- Blowdown
- Condensers
- Filters, Strainers and Screens
- Generator Purge
- HVAC System
- Compressors
- Valves
- Tagging Procedure
- Waste Treatment Systems
- Steam-Water Cycle
- Demineralizers and Polishers

TABLE 3 (cont.)

LEVEL II

Course Titles

- Instrumentation and Control — Power Plant Applications
- Heat Transfer and Fluid Flow
- Power Plant Chemistry
- Technical Math II
- Computer Operations
- Technical Communications I

Module Titles

- Boilers
- Boiler Auxiliaries
- Heaters
- Economizers
- Electrostatic Precipitators
- Fans
- Feedwater System
- Condensate System
- Pumps
- Turbines
- Turbine Lube Oil System
- Turbine Protective System
- Turbine Turning Gear Operation
- Transformers
- Electrical Switching
- Turbine Control
- Transmission System Interface
- Generators, Exciters and Voltage Regulators

LEVEL III

Course Titles

- Technical Communications II

Module Titles

- Control Panels
- Boiler Operation
- Turbine Operation
- Generator Operation
- Start-Up and Shut-Down Procedures
- Operating Engineers Certificate (License)

- Many of the "basics"—physics, math, etc.—could be taught in a one-year (three quarter), postsecondary vocational or technical program. This would allow the power company to concentrate on teaching the specialty courses with site-specific laboratories or "hands-on" presentations, which should be a more cost-effective method of training. A model curriculum for this option is outlined in Table 4.

Utilities may have different levels of operator progression and the tasks performed at each level may vary. For these reasons, the modules and courses are designed to be taught whenever they are needed to fit the operator progression at any specific plant.

Continuing Activities

The curriculum planning guides outline the subject matter that should be taught operators and technicians working in coal-fired power plants but do not provide the user with text materials. TERC is currently compiling a Resource Handbook,

TABLE 4: Power Plant Operator

Table 4 shows the recommended sequence of courses that could be taught in the vocational-technical school option. The quarter system is used assuming 10 full weeks of class and laboratory activities per quarter.

	Classroom	Lab	Contact Hours
First Quarter			
Technical Math I	3	0	3
Unified Technical Concepts I	3	8	11
Technical Communications I	3	0	3
Hand and Power Tools	1	3	4
Plant and Laboratory Safety	3	3	6
	13	14	27
Second Quarter			
Technical Math II	3	0	3
Unified Technical Concepts II	3	6	9
Technical Communications II	3	0	3
Fundamentals of Electricity	3	3	6
Power Plant Chemistry	3	2	5
	15	11	26
Third Quarter			
Computer Operations	3	3	6
Unified Technical Concepts III	3	6	9
Blueprint Reading	1	3	4
Heat Transfer and Fluid Flow	3	3	6
	10	15	25

which will catalog existing instructional materials that are suitable for courses in these three curricula. The Resource Handbook when used in conjunction with the curriculum planning guides should provide training organizations with a program resource reference of immeasurable value, obviating persistent and expensive *RE*development of existing materials.

The Resource Handbook lists instructional materials, training aids and packaged courses. It provides a description of the materials, format, terms, and addresses and telephone numbers of the material source for further information or ordering. Additional sections will list equipment sources, information sources, related professional societies and trade associations, and sources for national codes and standards.

The Handbook will be compiled in looseleaf format to facilitate updating, and blank sheets will be included for the addition of new sources.

When the Resource Handbook is completed, it will be used to determine areas where training materials are needed. Instructional modules will be developed in these areas.

Also, at the completion of the Resource Handbook the dissemination effort will begin. One EPRI-sponsored national workshop will be held, followed by a series of regional workshops. The purpose of these workshops will be to make public educators and utility training coordinators aware of the project and the availability of curricula, instructional materials, and assistance in implementing/adapting training programs.

Training Programs of a Public Utility

Sondra J. Gillice, Manager, Human Resources,
Potomac Electric Power Company, Washington, D.C.

Rather than simply outlining training programs of a public utility, I'm going to also take a broader approach and look at the electric utility industry in general, since I also serve as Chairman of the Training and Management Development Committee for Edison Electric Institute.

It has been said in recent times that the electric utility industry is the bellwether industry. Well, it may not be *the* bellwether industry, but there's not much disagreement that it certainly is one of them. This poses opportunities and challenges to an industry which not too many years ago functioned as "business as usual."

It's safe to say that one of the most significant changes and challenges facing us today involves people and the education and training of them—not just employees but our public as well.

In the past, the education and training of our employees was almost exclusively "on the job," but no longer. Technological changes, innovations, efficiencies have required, in fact demanded, that formal training be "on going" and continuing; not only for present jobs but jobs that we foresee in the future.

Let's look at what's been happening in the human resources field in the private sector and what impact that has, and will have, on future education and training needs.

The associated employee costs continues to escalate.

BENEFITS

A continually increasing cost coupled with projected slow or even no growth; the advent of ERISA and increased administrative costs.

PRODUCTIVITY

A major problem in this country as productivity continues to decline; many employees are earning more money but working less.

GOVERNMENT REGULATION AND INTERVENTION

There is more and more legislation affecting human resources management; no longer are solutions short and simple. We just can't solve human resource management problems today without evaluating all the statutes and legal ramifications.

EMPLOYEES—OUR KEY PROBLEM AND GREATEST POTENTIAL

Employees will continue to be older, better educated, more highly skilled and independent; they will question management decisions and expect and demand a better quality of work life. Retention of key employees will become critical and ensuring development of minority and female employees is essential. We need to ask, *"Are our employees managed well?"* Mid-career changes, technological changes provide human resources managers with a great challenge and opportunity to ensure effective training and placement occurs.

How *will* the training managers and human resources practitioners deal with these challenges in the eighties?

Well for one, our industry foresees continuing expansion of craft and skill training. This kind of training requires a great deal of "front loading costs." We're talking big money; equipment, facilities, and land in order to "simulate" the real world if the training is to be efficient and cost effective.

It is very possible in the future there will be joint ventures between neighboring utilities or even industry-wide facilities in order to maximize efficiency and control costs. Under the Edison Electric umbrella, our industry is beginning to police and train our own. More and more the industry is pulling together to maximize efficiencies and hold down costs in training areas such as Power Plant Operator Training, and Supervisory Training.

Secondly, there will be continued expansion of professional training, for example, engineers, of all disciplines and lab technicians. We need increased and expanded college relations programs—working with universities to influence curriculums such as power engineering and instituting speakers' programs. The Training and Management Development Committee of Edison Electric Institute sponsors a power engineering educators award in conjunction with the annual American Society of Engineers' conference. If you're an engineer today, it is a sellers market. We must award scholarships, as PEPCO does with some local Washington Metropolitan area universities and sell the challenges and opportunities we have in our respective fields in order to compete.

The theory and practical application of management supervisory training will need reworking in the eighties. A more skilled workforce requires more effective management and this requires increased training and education. Management *must* be held accountable for human resources' performance including Equal Employment Opportunity. As managers, we must develop, and then measure performance against prescribed standards of performance. These needs may be met internally and through university sponsored programs. And if you in higher education do not meet our needs then we, as well as others, will do it ourselves. The electric utility industry under the auspices of Edison Electric Institute did just exactly that about twelve years ago. We had a need for an intense and broad based executive development program that was directed toward our officer level employees. Our research revealed there was not a program on the market, so specialists in our industry joined together to create one. Today, that program limited to 40 executives, receives one-third more applications than it can handle. The "Hershey" program, as it is known in our industry because it is held each year at the Hotel Hershey, is famous inside and outside the electric utility industry for a quality and hard driving four week executive development program.

Fourthly, we foresee increased joint efforts between secondary educators and our industry to meet the projected skilled labor force shortage in the future. This may be the largest challenge of all; and we're behind. We need to be working together now to educate young men and women about future jobs and the knowledge that is required for these opportunities.

And last, mid-career changes, due to technological advancements, changes in life style or whatever, provide a big market for retraining and redirecting the human resources in our individual companies, universities, and agencies. We must be ready for this redirection effort in order to maximize the utilization of the work force.

Earlier, I mentioned the education of our publics, and even though you may probably be more interested in our employee education and training—we at PEPCO view education as very broad. To us it also means education, information, and mutual understanding with our shareholders, customers, government agencies, contractors, our employees; in effect all with whom we come in contact. It means to communicate, to promote exchanges in order to increase understanding of what our mutual problems and challenges and opportunities are—we do this through our Speakers Bureau, publications, educational exchanges and meetings with local and federal governments on specific and general topics.

In short, we are *all* in this together; only through planning and joint efforts will this country meet its future energy work force needs in a cost effective manner. It is critical that we always keep our eye focused on the bottom line; a well trained and motivated work force who contribute to greater productivity and profitability. Together, government, education and industry can do it.

Energy, Education, and Economic Development

Ann M. Martin, Associate Commissioner for Occupational Planning, Bureau of Occupational and Adult Education, U.S. Office of Education, Washington, DC.

INTRODUCTION

As everyone vividly knows, oil prices in the U.S. have skyrocketed since the 1974 oil embargo, and most experts foresee this trend continuing. It appears that the basic cause of these increasing costs is not only the OPEC cartel but also, the simple fact that cheap, easily accessible world oil supplies are dwindling while the world industrial demand for oil is increasing. Some expect that by 1985 or 1990 the world's oil production capacity may reach an estimated 80 million barrels a day (compared to 60.7 million in 1978), after which production will decline. This continued reliance upon oil necessarily means that continuing world economic growth is impossible if industry remains dependent on this resource.

As individuals, we frequently view the detrimental effects of the soaring fuel costs solely in terms of the hardships it imposes on driving our cars or heating our homes. Actually, the most sinister effect of the spiralling fuel costs has been on the overall American economy. Despite the best efforts of the Administration to hold down the wage-price spiral, the American economy has placed increasing reliance on imported oil as our own producing reserves dwindle. While it only costs OPEC around $2.50 a barrel to produce the oil, this international cartel has artificially raised the selling price from $6 per barrel in 1973 to the present $30 a barrel, and even higher prices exist on the spot market.

The resulting inflation has caused a decline in the economy from an average real growth rate—after inflation of 3% in the 1960's to only 1% currently. This inflation—which is now running around 13% has resulted in a discount interest rate of 13%. In practical terms, this means that borrowing money for most business and industries is very expensive with interest rates of 16% to 17% not uncommon.

When money is this expensive, industry is inhibited from recapitalizing, inventories are cut-back, and a general belt-tightening occurs. Lay-offs result in selected industries—witness the current state of the autmotive industry—and unemployment results. Meanwhile, salaries of workers increase in an attempt to keep pace with inflation, thus pushing them into higher tax brackets and decreasing their purchasing power. And while the GNP has been slowly increasing, the number of persons entering the work force or seeking employment has increased even faster. The net result has been a significant decline in real per capita income and productivity during the past decade.

In brief, during the past year the U.S. has had: (1) A 13.3% rate of inflation—50% of which can be directly attributed to the cost of oil—the second highest rate in American history; (2) A 1% decline in overall personal disposable income; (3) A balance-of-trade deficit of 25 billion dollars; and (4) The rate of worker productivity fell 2.1%.

While such economic ills cannot be solely attributed to shortages or to the high cost of oil, it has definitely been a major factor. For instance, the amount of U.S. dollars that go abroad to pay for oil, about 50 billion dollars last year, is responsible for the entire U.S. balance-of-trade deficit. Were it not for petroleum imports, there would have been a surplus. Since a larger percentage of personal income is now going for transportation, power generation, and heating oil, there is less money available to purchase other consumer goods. Furthermore, since fuel is a factor in the cost of goods—either directly in their manufacture of in their transport—the prices for American products has risen faster than they would have without the soaring petroleum costs.

If energy prices continue to spiral upward, it is apparent that the deterioration of the U.S. economy will be exacerbated. This will not only mean a declining standard of living for our now relatively affluent population but also render impossible the material advancement of the existing disadvantaged groups. Only if the cost of energy is controlled can our economy move out of its current malaise and regain its traditional dynamism.

Energy Problem—Number One Priority

The Administration has viewed the energy problem as its number one domestic priority. (Many feel that another top priority of the Administration—youth employment—could be tied into this economic priority in a meaningful way.) Upon entering the White House in 1977, President Carter presented comprehensive legislation to Congress outlining his National Energy Plan. In October 1978 Congress passed the National Energy Act, and the President further elaborated his position in his July 17, 1979 energy address to the American people.

In effect, the Administration has pledged that the U.S. will never import more than 8.5 million barrels of oil a day. December 79 imports were running 6.415 million barrels, and petroleum products 2.112 million barrels a day or 8.527 million barrels.

Over the short term, increased domestic oil and natural gas production combined with strict conservation measures will help to fill the gap between domestic supply and demand. Authorities agree, however, that if the American economy is to prosper, the long range answer to the energy problems is to tap such alternate forms of energy as coal, oil shale, nuclear, solar, wind, ocean, and biomass (these are fuels made from vegetation and wastes). Thermal power (natural hot water) already is heating a few cities in the Rocky Mountains, and is also being explored along the East Coast.

National Energy Plan

In late 1979, President Carter proposed a $20 billion dollar energy plan encompassing the development of the following *primary energy technologies:*

1. Liquefaction of Coal—(synfuel—to provide gasoline diesel oil, fuel boiler oil, etc.)
2. Gasification of Coal—(to provide gas)
3. Fission—(nuclear reactors)
4. Solar energy—(surface wind, passive and active solar heating, photovoltaic cells, and solar boilors)
5. Geothermal—(hot rocks, steam originating from the hot rocks, meltrane)
6. Fusion—(fusing atoms)
7. Oil Shale—(obtaining oil from the mineral in which it is bound)
8. Liquid hydrogen—(to propel automobiles, planes, etc.)
9. Ocean thermal-electric conversion
10. biomass—(ethanol—grain alcohol, methanol—wood alcohol)

Specifically, the plan calls for:

1. Accelerating energy research and development programs directed at achieving greater long-term energy independence.

2. Placing greatest funding on technologies with the highest potential payoff in terms of recoverable resources (fossil and nuclear).
3. Greatly increasing the federal investment in high risk technologies, and continuing to expand the investigation of other technologies where they can make significant contributions to meeting the long-term energy requirements such as solar and nuclear fusion.
4. Encouraging cost sharing with private industry (coal liquefaction demonstrations) and avoid undertaking research and development which is more appropriately the responsibility of the private sector (areas of conservation technology).
5. Supporting the commercial demonstration of synthetic fuel production from coal and oil shale.

To provide alternatives to undesirable dependence on oil and gas, the nation must undertake a program of *technology development* which will be technologically difficult, costly, and time-consuming. The problems of transition to new energy sources are difficult. New domestic energy sources are potentially available. Indeed, solar energy and nuclear breeder reactors and fusion represent essentially inexhaustible energy sources—but there are significant economic, environmental, social, and technological problems to be solved before these new energy sources will become adequate supplements for fossil fuels. Meanwhile, existing domestic alternatives in such forms as *abundant coal resources,* and the full benefit of *nuclear light water reactors* cannot be realized without further technological improvements.

FORECAST ENERGY TECHNOLOGY:

For the near term (now to 1985) and beyond, technologies that will make major impact are: (1) direct utilization of coal in industry/utilities; (2) nuclear converter reactors; and (3) enhanced recovery of oil and gas. For the mid term (1985–2000), the technologies that should make major impact are considered to be: (1) synfuel—gaseous and liquid fuels from coal; (2) oil shale; (3) tar sands; and (4) geothermal.

FUTURE FACILITIES

For the long term (past 2000), the technologies that should make major impact are: (1) breeder reactors: (2) solar; (3) biomass; (4) fusion reactors; and (5) hydrogen.

The following table provides an assessment of the number of major energy plants/facilities that will be required in the year 2000 in relation to those existing now.

TABLE 1

Type of Energy Facilities	Number of Equivalent Facilities Potentially Required in 2000	Existing 1975
1. Fossil Power Plants	500 to 800	400
2. Nuclear Power Plants	500 to 800	37
3. Solar Electric Power Plants	50 to 100	0
4. Synfuel Plants	70 to 150	0
5. Shale Oil Plants	40 to 80	0
6. Geothermal Power Plants	40 to 100	1
7. Coal Mines	1600 to 2300	640

The foregoing table gives us an idea of the gigantic task this country has to improve on the state of the art and develop new primary technologies to enhance recovery of energy.

It should be borne in mind that it takes a technology a span of 25 years or more before it makes an impact in the market sector. For example, the first chain reaction in a nuclear reactor took place in 1942 preceded by 10 years of active research in Europe and in this country. It was in 1955 that electricity generated by the nuclear reactor was used in a national electric grid. Today, after 40 years since the first nuclear chain reaction, nuclear power provides approximately only eight percent (8%) of electricity produced.

Basic Energy Science

Basic energy science provides for needs for future technological advances. The basic strategy of the National Plan for Energy Research and Development is that the nation must rapidly change to new energy technologies and new resource bases. Much of the research to accomplish this massive task will be developmental and applied, and will be performed by the private sector. In the case of fundamental research, most basic research activities will have to be supported largely by public funds.

One thing is certain, the advent of the new technologies associated with alternate energy sources will not be the occasion for reinventing the curriculum wheel. By and large, the fundamental technical programs already exist. All that is required is they be reoriented and complemented by new curricular elements which focus upon a specific area of the energy industry. It is in the aforementioned energy technologies and supporting technologies that we will have to introduce new curriculums and/or modify existing curriculums.

Energy Curriculum Development

Now let's stop for a minute and look in a little more depth at the areas of energy technology to be introduced into the curriculums in the next decade. Based on our earlier analyses, these are:

1. *Coal Mining Technology:* Surface and deep coal mining technology has progressed a long way from the pick and shovel days and the mule drawn carts. Huge automatic machines with automatic loading devices operated by very few people can now work deep mines. A new spectrum of skills, however, is now required in the operation and maintenance of such equipment. Both surface and deep coal mining have considerable environmental implications which must be taken into consideration. As in the case of other energy areas, the environmental impact is considerable and must be planned for and included in the cost of producing energy by these new technologies.
2. *Oil Shale Extraction and Mining:* There are hundreds of millions of barrels of oil shale both in the United States and Canada. This latter country is already proceeding with the mining of its oil shale and the extraction of hydrocarbons from it. This process will impact curriculums in mechanical and petrochemical technologies, civil engineering, and environmental technology.
3. *Tar-Sand Extraction:* There are again billions of barrels of oil locked in tar sands. They are, however, very difficult to recover, and generally require the consumption of one barrel of oil in order to extract three barrels of tar-sand oil. In addition, the steam extraction process requires environmental controls of a very stringent nature as California has discovered. All of these controls add to the cost. The most significant impact will be in environmental curriculums because of air pollution attendant to the recovery process.
4. *Conversion of Solid and Heavy Hydrocarbons to Middle and Light Distillates:* This is mothing more than the liquefaction and gasification of coal. Both processes have been known for some time. They were invented prior to World War II. They can, however, be made more efficient and, again, have their environmental implications. Petrochemical operators and technicians will be required to operate the new plants required by this process.
5. *Conversion of Biomass to Light Distillates or to Direct Energy Production:* This simply means the distillation of city gar-

bage or starch rich flora into ethyl and methyl alcohols which can be used as a fuel in combination with gasoline to extend the amount of fuel oil available for motor vehicle consumption. Distillation plant operators will be needed nation-wide.

6. *Nuclear Technology:* This is a technology which a lot of people wish would go away, but will not. By the end of the decade, over 200 light water reactors and several heavy water reactors will be providing inexpensive power for the country. Down the road, liquid metal reactors which are more efficient and which have been used in the Navy's Atomic Program for the last 20 years, will eventually replace the light water reactors. Sometime during the middle of the next century we hope to see fusion reactors. This is a new type of atomic energy which produces very little radioactivity and has minimal environmental impact. When this day arrives the world will have an inexhaustible, inexpensive source of energy. Motor vehicles will probably be operating on liquid hydrogen which can be readily electrolized from sea water. In the meantime, each nuclear plant will require several hundred technicians, maintenance and security personnel.
7. *Geothermal Technology:* There are many areas of the country where the geology permits access to hot water relatively near the surface for the generation of electricity and steam. The entire city of Reykjavik in Iceland is so heated and powered.
8. *Hydroelectric Technology, including Low Head Hydro-Dams:* Hydroelectric technology is nothing more than water power going from a high level to a low level and turning a turbine in the process. Low head hydro-dams would harness the power of the ocean tides in certain areas where a sufficient head of water can be harnessed and then released to produce electricity by this means. Such plants will require technicians skilled in electro-mechanical and hydraulic engineering.
9. *Electric-Optic Technology:* This technology employs lasers in the production of energy by means of nuclear fusion reactors. The Division of Research and Demonstration, Bureau of Occupational and Adult Education, United States Office of Education, has already developed curricular for one such program.
10. *Solar Technologies:* There are essentially three basic types. The first is a heat exchange panel which circulates a hot liquid by means of direct radiant energy transfer between

the sun and the solar panel itself. The second is a photovoltaic cell, a solid-state device capable of transforming the light of the sun directly into electrical energy. And finally, solar boilers which are nothing more than focused sunlight onto a steam boiler which turns a generator.

All of these technologies have their use and their economic limitations; unfortunately solar energy, though much touted, has yet to realize its economic benefit. Electrical wiring, plumbing, carpentry and stationary engineering are the only technical skills needed for solar energy, and little curricular development is anticipated.

In addition to all of the above work force needs, there will be a demand for environmental technicians capable of controlling the impact on the environment of these new technologies. The number of technicians to be needed, the types of skills required, and the job locations are all imponderables until we get our energy act together. Next, curriculums on health technologies relating to all of the aforementioned primary and supporting energy technologies will have to be modified and new courses introduced. Finally, a need for new transportation technology relating to all of the above should be expected.

All of these curricular elements have an impact on teacher training at the post-secondary level. Existing programs of mechanical, civil, electrical, transportation, chemical, mining process engineering, bio-medical, environmental engineering, provide the basic foundation upon which the specific curriculum elements may be added. There seems to be little doubt that the future economic well-being of the nation and its dependence on OPEC nations, depends on training and developing our students in the relevant technologies.

The Leadership Role of Education

The awareness role of education in America's energy program is immense. First, and foremost, it is the educational community's responsibility to make the American public aware of the gravity of the energy crisis. The solution to the energy problem cannot be achieved solely by government directives. Rather, the solution requires the wholehearted support of all of the American people.

Naturally, before the solution of any problem can be found, it requires the recognition that a problem exists. Unfortunately, at the present time too many American people deny the existence of any energy shortage. An Associate Press-NBC poll conducted last March showed that 68% of the American people view the oil shortage as a hoax concocted by the oil companies and the government.

It is essential that the education community point out that the oil shortages are real. Teaching this should begin at the earliest ages, not as an effort to indoctrinate students with any particular energy view (pro- or anti-nuclear, for example) but as an effort to make clear the reality of the problem of an energy shortage and the possible alternative solutions. General education should especially focus on the need for conservation practices.

About one-fifth of the energy used in the United States is used in our homes. Students should be inculcated with the vital importance of car pooling, turning off lights, insulating homes, driving at slower speeds, and shopping for energy-efficient products. What might appear to be a small savings in the average household, can add up to large savings if every family takes part in the effort.

While education in general can improve the conservation practices of American consumers, vocational education can best affect the conservation practices of American producers. America needs skilled workers in almost every field who are trained in energy conservation. Vocational education should infuse elements of conservation into all of its courses. Students enrolled in the building trades, for instance, should be taught about insulation. Students trained to work with engines should be taught how to operate them at peak efficiency. In the process of learning about conservation, students can engage in projects which will make their schools more energy-efficient as well.

It is especially vital that education continue to encourage close cooperation between the education community and the private sector—business, industry, and labor—as these primary and supporting energy technologies develop. The private sector knows best what its needs will be. It can communicate those needs to the schools, and thus bring education into better alignment with the marketplace. The private sector also has the facilities which could be used for training purposes.

Mechanisms to bring about better collaboration between education and the private sector in the Industry-Education-Labor coordination effort are already in place. The Office of Occupational Planning in the Bureau of Occupational and Adult Education, has been given major responsibility for providing leadership and technical assistance in the development and improvement of Industry-Education-Labor Action Councils at the local level. These Action Councils represent the "power structures" of their respective communities, and seek to assist the schools in developing a total program more responsive to the complex and changing job market and the economic and energy development needs of the area. It is not the function of the Office of Occupational Planning or national and statewide I-E-L organizations to mandate uniform procedures and policies for local school boards and communities, but rather to recommend and assist in the development of the I-E-L programs most appropriate for each individual community.

Energy, Education, and Economic Development

The Office of Occupational Planning is trying to do its share in solving the energy problem. For example, an ongoing study in our office is a study of the needs of energy-related technologies for the sub-professional engineering field. An essential consideration in one of the Office of Occupational Planning's major initiatives—Vocational Education and Economic Development—is that of energy education. The primary purposes of this initiative relating education, energy and economic development is to bring together individuals from education, government, economic development, the private sector and the community to plan for future work force and related education needs of the U.S. economy. The ultimate goal of developing these broad linkages is to establish a process by which government, the private sector and the community can provide greater input into education in order to enable education to assume the leadership role now essential to the economic development process.

A major problem with current American public education is its frequent failure to provide the type of training related to opportunities opening up in the job market. This includes training more of the disadvantaged and handicapped to assume their rightful roles in the workplace of America. Furthermore, we have the situation in which numbers of educated individuals are unable to find jobs (unemployed), or at least, are not able to make use of their education on their jobs (underemployed). Not only are these particular individuals harmed but so is the overall U.S. economy which is less productive than it would be if its labor force were well grounded in the knowledge techniques, and precision operations of the developing technologies.

When I speak of providing the type of training demahded by the job market, I am referring not only to the current job market, but also to the job market five or ten years in the future, the characteristics of which will be significantly different from that of today. It is essential to realize that students will not be entering today's job market but the job market some years from now.

In referring to the needs of the future job market, the labor needs of the emerging energy fields—solar, nuclear, synthetic fuels—need to be analyzed. The labor demands in these emerging energy fields are, as we have seen, quite miniscule at the present time, but quite likely will be very great in the near future.

A major thrust of the Education, Energy, and Economic Development initiative is: (1) To see that technological forecasts are provided in selected industrial sectors of the economy which makes up the gross national product so that inputs from these forecasts are used in occupational planning; and (2) to analyze the demand for various occupational trades of the American Industry Trade Associations and compare these estimates of demand with the supply of resources to fill these jobs. In essence, what to do with the lag in the two curves is occupational planning.

Realizing that economic conditions vary significantly throughout the nation, the Office of Occupational Planning is not attempting to establish a single national program, but, rather, to foster a local and regional planning process to deal with local and regional problems.

Currently, we are concentrating on developing state and regional economic development conferences and follow-up workshops. It is expected that these conferences will spawn the development of local, state, and regional planning efforts and models. The Office of Occupational Planning will serve in the role of a catalyst in the development of these procedures, processes and models.

An economic development conference is tentatively scheduled for South Carolina later this year and just yesterday, I attended a conference for the Northeast region in Boston, cosponsored by OOP and the National Association of Industry-Education Cooperation (NIEC). The Conference was on Human Resource/Economic Development, a concern for revitalizing the Northeast.

SUMMARY

I hope that this description of the Office of Occupational Planning's vocational education and economic development initiative underscores the interlocking relationships between education, energy, and economic development. All too often these fields are viewed in isolation. As businessmen, economists, energy experts, or educators, we all, as we know, tend to become completely absorbed in our own particular specialities, while becoming oblivious to the larger economic, social and educational picture. Only when individuals in various, disciplines and specialty areas work together to solve mutual problems and concerns can our nation surmount its current economic and social problems and move on down the road to a more prosperous future.

Energy Impacts on Our Health Delivery System

Gordon W. Berg, Division of Energy Policy and Programs, H.E.W., Washington, D.C.

INTRODUCTION

The Division of Energy Policy and Programs has worked for several years to raise the awareness of health facility administrators and staff of the need to reduce their dependency on fossil fuels, implement total resource planning management, and encourage the health sector to investigate and use alternate sources of energy, such as solar and geothermal. However, the concerns, problems, and rationale for action expressed here, are transferable to the education sector and the community at large.

Health and education, after all, are not that different; both are service oriented and both are large systems. Both depend on well-educated providers, and share systems that depend in large part on physical buildings—hospitals and other medical facilities, and schools and universities. Both have to look to transportation systems to funnel in clients as well as workers.

Health and education are part of the same economic system, and will be subject to the same constraints. The projection for the immediate 1980s is increasing energy prices with decreasing supplies which will contribute toward continued inflation and major economic disparities.

Based on recent current and projected events it should be quite apparent to people in decision making roles that all economic, political and social ground-rules that have traditionally been used for decision making will have to be revised. Morris Cohen, Chief Economist for the New York Firm of Schroder, Naess, and Thomas, in an article which appeared in the February 24th issue of the Washington Post reported he believes the reason most forecasters erred in their economic projections in 1979 was they relied too much on historical precedent and particularly on the use of complex econometric models. The problem with computer models, Cohen says, is that they're programmed to forecast mechanically, almost solely on the basis of how the economy has reacted in previous years, and can't cope with changes in behavior. "But we're in a period where there are no parallels," Cohen says, "and the models don't allow for judgment on individual components." In reference to the economy, Cohen says, it is much more vulnerable than it's been in previous years and inflation is more likely to make a serious impact on consumer and business decision making.

I believe, unfortunately, that there are many decision makers that are operating as naively as did the majority of the economic forecasters, and for the same reasons, they are erroneously basing their decisions on past events. The decision makers that must now emerge are those like Morris Cohen who essentially threw away the economic history books and relied mostly on his eyes and ears to tell him what was happening. In support of this concept, I am going to review the current energy impact on health care delivery and then after throwing away the book, make some observations, projections and recommendations.

Energy's impact on the health delivery system, or any other system, falls into three main areas:

1. Escalating Costs—
   Energy is no longer cheap. The landed cost of imported oil to U.S. refiners, rose in one year (January 1979 to January 1980) from $15 a barrel to an average of $33 a barrel.
2. Dependability of Supply—
   International crisis politics could at any time cut off the oil which supplies nearly half of our country's petroleum requirements.
3. Availability—
   This nation is rapidly depleting its domestic supplies of oil. Though we have nearly one-fourth of the world's estimated coal reserves, and theoretically, have access to inexhaustible sources of energy such as solar and geothermal, in reality we do not have the technology to tap those sources for immediate practical use.

Let's examine the current and projected impacts of these areas on health resources and delivery.

Costs

In the past 2 years, energy costs for hospital operation have risen from one percent to as much as 10 percent in some areas. Under present reimbursement systems, these costs are passed through to consumers and third party payors, and thus are part of the rapid escalation in health care costs.

The Health System needs reimbursement insurance premiums, and commercial participation in group health plans. For the individual consumer increased insurance premiums, coming at a time of general inflation and subsequent reduction in disposable income, will mean a future of substantially decreased participation in health insurance plans. More and more large purchasers of health care services will turn away from the private health care sector to the pre-paid concept of Health Maintenance Organizations as a way of saving every scarcer dollar. There is indication in California that this is already happening. Both hospitals and private physicians are seeing a decrease in their private patients who are going to the increasing numbers of HMOs.

Increasing numbers of hospitals and nursing homes will close as a result of astronomical cost increases in operation. Supply and equipment costs will rise due to the ever larger percentage of energy expense in manufacturing and transportation. There will be a corresponding decrease in the numbers of patients who cannot afford either the transportation to the facility, or the increased costs of care, particularly if those costs should be uninsured.

In West Central Illinois, one of the Health Systems Agencies (part of a network of health planning bodies which exist under the health planning law administered by the Health Resources Administration) has already started a study of energy as it affects access to health care facilities. They are plotting the travel times for all inpatient and ambulatory care facilities in their area. For residents on the fringes of their service area, every trip to a medical facility means the consumption of 2 to 2½ gallons of gasoline. Should gasoline rationing go into effect, or gasoline prices rise to completely unaffordable levels, many of those patients will not be able to travel to facilities. For some patients, that would be an inconvenience. For others, it would be a matter of life or death.

Dependability of Supply

Based on a survey we conducted in 1976, an alarmingly high proportion of our Nation's hospitals rely on a single fossil fuel—13 percent use only oil, and 32 percent use only gas. In certain geographic areas, the percentage of single fuel source reliance is even higher. If OPEC should announce a total oil export embargo to this country, or if war should cut all transportation of oil, the health effects would go beyond the physical envelope of our hospitals to all segments of our society. In hospitals, the following scenario is a real possibility:

- Hospitals close or cut services by half;
- Life support and laboratory equipment lose reliability, shut down, or must be operated manually, sometimes by personnel who have not been trained for such equipment operation.
- The ability to shift patients among facilities is either reduced, or impossible, with resultant loss of life.
- Facility staff is required to operate without essential backup equipment; other staff find it impossible to even get to the facility and thus those that are there work double duty.
- Among the population, medical emergencies can find no way to travel to a hospital or physician. In winter, the old and the young suffer exposure in unheated environments.
- Medical supplies are delayed or not delivered to patient treatment centers, particularly those in rural areas.
- Production/manufacturing of medical disposables and drugs is reduced, or stopped.

Availability

Grim as the above may sound, the only difference between dependability of supply and availability, is degree of permanence. An energy disruption would be over eventually, while lack of available energy sources as I define it, is a permanent condition.

In planning for this future, we not only need to address how our health care delivery system must be changed, we must also consider what effect the development of new energy forms will have on health in general. But most important of all, we MUST PLAN. Energy related problems affect health and human services in direct and indirect ways. All of us can see some of the effects, but others are obscured at various levels within the socioeconomic complexes within which we operate. In our specialized society, health and human services managers have remained aloof to energy developments and problems, because those are "the problems of the energy people." They lack a true understanding of the potential scope, the ripple effect, energy problems have for their operation, and the gravity of those problems.

To underscore the gravity of these problems, I want to share the following with you.

Fuel shortages will be felt beyond hospital heating and electricity requirements extending to some of the very tools of the medical trade. Lt. Col. Gary Clark, M.D., with DOD Surgeon General's Office, has worked with our program to pinpoint one of those critical areas which might well be ignored in time of fuel rationing—the medical plastics industry. Although only 0.2 percent of the oil consumed in this country goes into the medical plastics industry, Clark draws a doomsday model based on experience in the 1973 oil embargo. At that time a 15 percent shortfall occurred in petroleum products and seriously threatened the availability of medical plastic supplies. The very fact that the medical plastics industry is so miniscule may not be at all protective. The next severe oil supply crisis may prove disastrous because petroleum allocation plans may not take the medical petrochemical industry into account, because its needs are so comparatively meager. Dramatic changes will occur if protracted fuel shortages cut off the medical plastics supply. Disposable syringes and heart valves come from plastics; many pharmaceuticals depend on petroleum based solvents for their manufacture. As Clark has asked, "How can you perform asceptic techniques without plastic gloves."

Others have realized that urgency of fuel allocation may well mean that some important societal functions may fall between the cracks. Administrator of the Economic Regulatory Administration, Hazel R. Rollins, testifying before the House Subcommittee on Energy and Power, on January 31, 1980, pointed out that expediting rationing over a short time would involve certain tradeoffs. She said, "The shorter the implementation period, the less time can be devoted to potential administrative and enforcement problems, such as establishing verified lists of eligible recipients and protecting against fraud."

Public hearings are being held now on the proposed Department of Energy standby Federal Emergency Energy Conservation Plan. That plan proposes a number of conditions which would impact enormously on health providers, and patients, including:

> A 4-day work week of 10-hour days for use during a severe National fuel shortage in those States which do not meet the fuel conservation target set by the President; an employer program for reducing commuter use of private vehicles; and a vehicle sticker program to prohibit use of a vehicle one or more days per week.

Philosophy of the Future

What has already happened, the proposals for fuel allocation that will happen, and scenarios for the distant future all shape an amorphous, but rapidly jelling philosophy of the future.

These philosophical directions come from many sources.

A well respected futurist is Amitai Etzioni, Professor of Sociology at Columbia University and Director of the Center for Policy Research. In the March-April, 1980 issue of NEXT, Etzioni outlined a future which will dramatically change health and education. He pointed out that our society currently employes seven out of ten workers in service industries (which include health and education). This country is entering a time when "our weakening economy simply cannot afford more and more services," he says, and predicts the slogan of the future will be "minimum competence." Students will not be graduated unless they command certain skills. Work force priorities will be reordered—more minors for example, and fewer graduate students whether they be in health care or other service areas. Etzioni also says there must be a shift of emphasis from service to heavy investment in the primary and secondary economic sectors (these are farming and mining, and manufacturing). The shift of emphasis is necessary because of energy—which is no longer cheap or easily available. The primary and secondary economic sectors will be devoted to applying the expensive technology necessary to capture and use different energy sources.

The Department of Energy even gives us a time frame of three phases for moving away from traditional energy sources:

1. From now to 1985, we will continue to rely heavily on oil. During this time, our only tool to combat energy shortages will be conservation.
2. From 1985–2000, we will move significantly from oil dependence to more coal and coal derived synthetic fuels, solar technologies, oil shale, unconventional gas supplies, and nuclear power.
3. Beyond 2000, the world will move further toward renewable energy sources and advanced nuclear technologies.

Those phases may well "slip" depending on political situations in the Mid-East, our ability to do more with less, and our collective National determination to bite the bullet and plow our resources into the future. However, it is clear that for the next five to 10 years, at a minimum, we must be a conserver society.

Shape of the Future

It is appropriate here, to outline for you my own scenario for the health care system of the future . . . a health system which has changed radically because of the impact of energy shortages and changes.

We will still utilize expensive technology, but, in health, that technology will be located in fewer places. There will be truly regionalized health centers for complex medical services, rather than having high technology equipment located in every hospital setting. There will be more attention to, and dependency on preventive health practices, including intensive consumer education. There are already trends in that direction. In the 1981 budget proposals for the Department of Health and Human Services, programs to prevent illness, disease, and injury will receive $859 million, an increase of $87 million. The aim of these programs is to increase public awareness that individuals, rather than elaborate and costly health care delivery systems, are primarily responsible for the collective well being of the Nation. Starting now, the phrase "patient, heal thyself" will have more meaning.

Within the 1980s there will be a big change in the numbers and uses of our Nation's present 7000 hospitals. More and more hospitals will be faced with decisions of merging facilities or completely closing their doors. Of course as nursing homes and hospitals close down, this will place additional patient loads on those facilities that do remain open until quite possibly they themselves are faced with economic crisis. The big dollar crunch will occur because hospitals' expenses will continue to surge, and at that point, when expenses soar past income—they will no longer be financially functional.

Future

By the middle of the 1990s, only 15 years from now, I believe we will have in place a different structure for delivering health care services. The following are some of the highlights of the structure:

1. There will be geographically distributed large medical centers offering complete medical care.
2. Satellites to the large medical centers will be community health facilities (hospitals) offering only limited health services.
3. Satellite to the community health facility will be neighborhood health centers.
4. Satellite to the Center will be mobilehealth units and personal neighborhood outreach services—such as home visits.

The hospital, as we now know it, with severe reductions in services could serve as a satellite to the large medical center. In addition to limited medical services, the hospital would also serve as a wellness center performing preventative medicine practices, such as multiphasic screening programs, the hospital could also be the focal point for laundry and meal services for specified community populations. Some of the other functions of the hospital could be providing day care services, nursing home functions and conducting training activities for some of the personnel required for the hospital, neighborhood center, mobile health unit, and outreach services. This system would place emphasis on providing routine health care at the lowest possible level.

Now that I have outlined my thoughts on the health care system as it will evolve over the next few decades, I want to strike a more positive note and talk about an organization which has been formed to help us plan intelligently for the coming changes. This organization, formed in November 1979, is called the National Alliance for Energy Contingency Planning for Health Resources. The National Alliance is an outgrowth of an energy contingency conference held in Washington, D.C. on September 20–21, 1979, developed and administered by the Division of Energy Policy and Programs. The Division is also responsible for the formation of the National Alliance. The National Alliance has a membership now, of more than 30 individuals who represent diverse elements of our health care system including the American Hospital Association, the Blue Cross/Blue Shield, representatives of Federal, State and Local Governments, and the military. This organization is taking a holistic approach to health planning, health care delivery, community government, and changing energy patterns. It represents the interests of those in the health care community who are on the firing line—who have to face daily the constraints of increasing prices, the potentials of decreased energy sources. Through the Division of Energy Policy and Programs' work with the Alliance, and as part of the Bureau of Health Facilities, the Division can address the concerns in cost containment, and in the availability and use of health care facilities. After all, if health facilities cannot get energy, the facilities will not be available, or used.

RECOMMENDATIONS

I will close with a few recommendations for changing managerial styles, and courses of action to insure the continuity of our health care system:

1. This nation must begin to operate as a national community, recognizing our inter-relationships.

2. Health planners/decision makers must encourage reduction of energy consuming activities. This would include integrating shut-downs of facilities so no single service is entirely lost to multi-facility communities.
   —multi-facility van pooling and trucking to increase staff and patient access to the locus of patient service delivery;
   —identifying and scheduling ways to combine in-facility and outreach services of hospitals, centers, and agencies from central key facilities to outlining areas;
   —encourage the use of telephone and visual audio systems for meetings and professional consultations.
3. Facilities must be encouraged to utilize alternate sources of energy, such as solar, geothermal, and recovery of waste heat.
4. There must be shared services along community lines, as well as health provider lines developed. This could mean, for example, that a facility dietary center could be used for other community groups. The facility, both an employer and employee within its community, must take a leadership role in community activities, especially those providing personal services of any kind.
5. Facilities should encourage development of patient/ family self care programs (injections, self dialysis, high blood pressure checks), backed by phone consultations and health education courses.
6. Facility administrators must prioritize their capital expenditures. A portion of their investment monies must be placed into energy savings activities to help insure their continued capabilities.

CONCLUSION

As I indicated at the beginning, the Division of Energy Policy and Programs has worked for several years to do what it can to insure continuity of health care in a changing time. The Division has administered Department of Energy funds through shared cost contracts to 12 health facilities to install solar power. Four more solar projects will be funded this summer. The Division has developed publications on conducting energy audits, on conservation and energy management, on cost savings from those audits, on solar and on geothermal. The Division has conducted conferences and seminars, and has worked alone and with others to collect data on hospital fuel use and conservation practices.

The Division alternates between optimism and sense of reality—both for the Nation and our health care system. The '80s will be a frontier, a time for opportunity, a time for change. This change is already starting at every level.

We are a Nation of individuals, and we see signs of change there. People are conserving. Farmers are exploring, developing and using methane and alcohol as energy sources. Individuals are experimenting, alone and in groups, with passive solar collectors. Science students in a Midwestern high school installed solar collectors for their class, and buoyed by that success, applied for and received a $5000 grant to install solar heating for other parts of their school.

We are a Nation of government, corporations, and industry. Department of Energy, in February 1980, displayed a newly developed bit for geothermal well drilling. The new bit is fitted with man-made polycrystalline diamond cutters. This bit may lead to significant reductions in well costs. RCA announced in February 1980 a breakthrough in photovoltaic cell production. These cells will be marketed in 1983 and have potential application for home heating and for transportation. More and more cancer patients are treating themselves with drugs at home with the help of portable pumps, and patients with digestive-tract difficulties are able to leave hospitals because of portable intravenous-feeding devices.

We are a Nation of systems, including health and education. In our transition from dependency on fossil fuel to energy independence, we must work together. The charge to educators may be the greatest of all for they will train, guide, and assist in the development of our future decision makers and planners. Through them we can say to our youth, "We can do, we can survive."[5]

Training Programs and Advanced Education in Solar Energy

Kevin O'Connor, Solar Energy Research Institute, Golden, Colorado

INTRODUCTION

Jobs related to the solar industry are becoming increasingly more bountiful. Our nation's educational institutions are responding to the popularity of the emerging industry by offering a vast number of courses, programs and curricula in all fields of solar energy. This paper will discuss the range, types, and quantity of solar offerings in the nation's post-secondary institutions.

The burden of meeting the U.S. energy workforce needs through training in the solar technologies will be placed on our educational institutions. One of the difficult questions related to this issue concerns the demand which the solar industry is currently creating relative to additional, specially-trained solar personnel. A quantification of this demand is not clear. However, a middle of the road figure, derived from the Solar Energy Domestic Policy Review, suggests that about 150,000 to 200,000 jobs of all types per year will be created from 1985 to the year 2000 in solar hot water heating and space heating and cooling applications if the President's 20% goal of energy needs supplied by solar are to be met by the end of the century.[1] While there will be a demand for jobs created by the emerging solar technologies, the actual number of jobs is a much disputed topic. In addition to Reference 1, one should consult a sample of projections of the impact of solar technology applications on the labor force.[2,3,4] These reports also summarize work done by others in solar labor force projections to provide a fairly complete picture through the year 2000.

This paper will suggest some of the cautions which vocational-technical schools, community and junior colleges, and other technical-type training programs should consider before adding such a program to their offerings. The question of whether one should be trained as a solar specialist, either graduating from a four-year or two-year institution, is a subject of debate not easily settled. If the labor force demands are, in fact, sufficient for additional solar engineers and solar installation and maintenance types, then it makes sense to train people in these specialized areas. The reverse argument suggests that training people in solar only may be unfair in limiting their career options. Only as the industry moves out of its relative embryonic state will the question be answered more definitively.

In the four-year academic institutions, it is suggested that four-year or advanced degrees giving someone a strictly solar title are not necessary. Instead, it is suggested that the pursuit of an academic degree remain in a traditional area of pursuit with solar emphasis. For example, one should pursue a mechanical engineering degree with solar course experience or related practical experiences, rather than just looking for a "solar engineering" degree.

Solar Technical Training Programs

Training programs are defined as those programs teaching technical training skill usually preparing a student or embellishing a student's present qualities toward a job in the installation and maintenance of solar applications.

Before one can describe training programs for solar applications, preliminary issues must be addressed relative to the need for solar training programs, both in terms of quality and quantity. In addition, it may be helpful to offer criteria which will assist an institution in the evaluative process leading to a decision on whether or not to offer a program. It is popular to be for solar today—people are curious about it, they want more information; others want to go into business. Yet, the concern of great importance must be for the student being trained in a particular skill in some solar applications. Will there be a job at the end of the educational process for the student being trained?

If this question is raised, as it should be, several different issues follow. For example, how should an organization or educational institution go about establishing a program need based on available jobs in the first place? This question was raised and recommendations were put forth in a SERI report[8] on technical training recommendations. To summarize the report, an organization should utilize an Advisory Committee consisting of local trade organizations (union and non-union), local solar businesses; and other selected community and regional experts who will be able to advise well in these areas. If the Advisory Board indicates a need for the planned program, it is then appropriate to move forward.

Another question which will be raised and which can be evaluated by Advisory Boards begs the question of the appropriateness of the training being offered. Does/will the course/program provide adequate training in the right skills? Is the duration of the course sufficient to cover the topic properly? Is ample time divided among classroom, on-the-job-training, laboratory experience, etc.? And finally: Will a program be planned which may serve present needs, but which will be outmoded in a short period of time? Is the effort of creating a program worth what might be a short-lived experience or is the program designed with adaptability and flexibility to change as the technology changes? As an example, will a program in the installation and maintenance of solar heating systems be easily accommodative to the addition of technologies such as wind energy conversion systems or photovoltaics as they become economically and technically more feasible?

In short, training should be based on available jobs, and not based on a popularity index which, if high, may unfairly train students for jobs which do not exist.

If, after careful evaluation of the local economy and potential demand for solar applications and jobs in the region, it is decided to press forward with a solar program, then several other critical considerations need some attention. Will funding be necessary? If so, what sources are available? Costs to establish a minimum solar laboratory can run from $20,000 to $50,000.[5] And finally: Where will the teachers come from to teach in the solar program? Depending on the size of the program in terms of the number of course offerings, and local student interest, this may or may not be a problem. Quality instructors in programs (at the technical training level) which can offer practical classroom and on-the-job-training experiences will help to create a successful training program.

Solar Energy Educational Information

Having now mentioned some of the problems of program establishment and labor force considerations, an assessment of the types, quantities and range of available solar educational experiences in the U.S. will be made. The statistics analyzed in the remaining portion of this paper are derived from the solar energy education data base, maintained as part of the Solar Energy Information Data Bank (SEIDB) at the Solar Energy Research Institute (SERI). The data base was created with the cooperation of the Office of U.S. Congressman George E. Brown, Jr. and the Congressional Solar Coalition. Congressman Brown's

Office and the Solar Coalition were responsible for mailing a survey instrument to the nation's post-secondary educational institutions. SERI agreed to be the processing agent for the surveys, and, thereby established the education data base in the SEIDB in the Fall of 1978.

Two publications of significance have been derived from the data base to date. They are the *National Solar Energy Education Directory,*[6,7] which lists by state all detailed course, program and curriculum information, and the *Solar Energy Technical Training Directory,*[8] which lists all technical training programs, generally leading to a certificate or associates' degree, or which provide substantial technical training.

Distribution of Solar Educational Activities in the U.S.

The distribution of institutions offering solar energy education in the United States is presented in Table 1. An institution qualified as being involved in solar energy education if it offered at least one solar-related course. A solar-related course was defined as one in which one-third of the course was devoted to teaching direct solar topics.

As of January, 1980, 760 U.S. post-secondary educational institutions (about one-fifth of the total) were offering at least one solar-related course.

Four hundred thirteen (413) institutions were colleges and universities offering some 82 degree programs, while 347 institutions were vocational-technical schools and community/junior colleges offering 153 technical training programs.

A more refined look at Table 1 indicates that three states (CA-83, NY-54, TX-34) have 171 or nearly one-quarter (22.5%) of the total of 760 schools in the U.S. with solar offerings. Thirteen states have 20 or more schools teaching solar in some form. California (11) and Texas (8) offer 19 of the 82 college and university degree programs in the U.S. The greatest numbers of colleges and universities offering solar are in NY (41), CA (32) and PA (23). These states contain almost one-fourth (23.2%) of the total advanced degree institutions offering solar in the U.S. One-fifth of the technical training programs are found in CA (22) and CO (11) with nearly one-half of the states (24 in total) offering less than two solar energy technical training programs. CA (51), CO (19), NC (17), and TX (17) are the leading states with institutions offering solar at the vocational/technical and community/junior college level. The 104 institutions in these four states represent 30.0% of the total number of institutions in this category.

TABLE 1: Distribution of Institutions Offering Solar Energy Education in the United States by State (January 1980)

State	Colleges and Universities Offering Degree Program	Colleges and Universities Offering Programs and/or Courses	Schools with Technical Training Programs	Voc-Tech Schools and Community/ Junior Colleges Offering Programs and/or Courses	Total Organizations with Solar Offerings	Organizations per 1,000,000 Population with Solar Offerings
Alabama	-	7	2	2	9	2.5
Alaska	-	1	-	4	5	13.1
Arizona	3	3	5	13	16	7.0
Arkansas	1	4	1	1	5	2.4
California	11	32	22	51	83	3.9
Colorado	3	9	11	19	28	10.8
Connecticut	-	10	3	6	16	5.1
Delaware	1	1	2	2	3	5.2
Washington, D.C.	1	5	-	1	6	8.5
Florida	4	8	7	12	20	2.4
Georgia	-	5	1	2	7	1.4
Guam	-	1	-	-	1	10.1
Hawaii	-	1	-	2	3	3.4
Idaho	1	2	-	-	2	2.4
Illinois	5	19	1	10	29	2.6
Indiana	2	10	3	6	16	3.0
Iowa	-	8	4	5	13	4.5
Kansas	1	7	4	6	13	5.6

LE 1: (Cont.)

	Colleges and Universities Offering Degree Programs	Colleges and Universities Offering Programs and/or Courses	Schools with Technical Training Programs	Voc-Tech Schools and Community/ Junior Colleges Offering Programs and/or Courses	Total Organizations with Solar Offerings	Organizations per 1,000,000 Population with Solar Offerings
ky	-	3	-	-	3	0.9
iana	-	5	-	1	6	1.6
	1	6	1	3	9	8.4
and	1	3	1	6	9	2.2
chusetts	5	15	6	12	27	4.6
gan	2	14	6	16	30	3.3
sota	1	12	2	6	18	4.5
ssippi	1	3	1	3	6	2.5
uri	3	15	-	4	19	4.0
a	-	4	-	3	7	9.3
ka	-	2	1	4	6	3.9
	-	2	1	1	3	4.9
mpshire	-	4	2	5	9	10.9
rsey	4	9	5	9	18	2.5
xico	-	1	4	6	7	6.0
rk	5	41	4	13	54	3.0
Carolina	2	10	6	17	27	4.9
Dakota	1	3	1	1	4	6.2
	4	18	2	8	26	2.4

TABLE 1: (Cont.)

State	Colleges and Universities Offering Degree Programs	Colleges and Universities Offering Programs and/or Courses	Schools with Technical Training Programs	Voc-Tech Schools and Community/ Junior Colleges Offering Programs and/or Courses	Total Organizations with Solar Offerings	Organizations per 1,000,000 Population with Solar Offerings
Oklahoma	-	3	-	-	3	1.1
Oregon	1	4	3	6	10	4.3
Pennsylvania	-	23	6	7	30	2.5
Puerto Rico	-	3	1	1	4	1.5
Rhode Island	-	2	-	1	3	3.2
South Carolina	-	5	6	12	17	6.0
South Dakota	-	4	1	1	5	7.3
Tennessee	1	9	4	5	14	3.3
Texas	8	17	9	17	34	2.7
Utah	-	2	2	2	4	3.3
Vermont	1	3	2	3	6	12.6
Virginia	2	11	2	9	20	4.0
Washington	1	4	2	8	12	3.3
West Virginia	-	3	1	1	4	2.2
Wisconsin	4	16	4	9	25	5.4
Wyoming	1	1	1	5	6	15.4
TOTAL	82	413	153	347	760	3.5 (U.S. Ratio

ource: Solar Energy Research Institute

Solar Course Offerings by Organization Type and State

Table 2 presents the distribution by state of the 1,740 solar courses offered in the U.S. by the type of organization in which the courses are available. Three-fifths (60.5%) of the courses are offered in the college/university setting, with one-quarter (26.9%) in the community and junior colleges and one out of ten in the vocational/technical schools. The category of "others" includes political action groups, adult/community education centers, professional associations, private business, government organizations and trade associations. The states with the greatest number of course offerings include CA (219, 12.6%), TX (130, 7.5%) and New York (124, 7.1%). These three states contain more than one-fourth of all the solar course offerings in the U.S.

It is interesting to note that 89 of the 176 or more than one-half of the vocational/technical schools with solar course offerings are in five states (NC-25, TX-23, NH-14, WI-14, CT-13). It is noted, however, that many of the junior/community colleges offer vocational/technical experience programs. Again, in the community/junior college area, a similar situation exists with the five most prolific states offering more than half the junior/community college courses (CA-101, TX-41, CO-40, NY-30, AZ-26 for a total of 238 courses out of 468 offered).

Solar Programs

A solar program is defined in one of the three following ways:

- *Solar Curriculum*—a program in which the student receives a degree or a diploma in a solar field—doctorate, master's, bachelor's, associate; e.g., "Master's in Solar Engineering"; "Associate Degree in Solar Installation".
- *Curriculum with Solar Study*—a program in which the student receives solar education while working on a related degree or diploma—doctorate, master's, bachelor's, associate; e.g., "Doctorate in Physics" with solar emphasis; "Bachelor's in Architecture" with solar design experience.
- *Solar Technical Training (Non-Academic Degree)*—a program in which the student receives a certificate for study in solar energy or a solar-related field; e.g., solar technician.

The distribution of solar program offerings in the U.S. is presented in Table 3. There are 243 programs in the U.S. in which five states (CA-31, TX-17, CO-16, FL-12, and NY-11) offer more than one-third (35.8%) of the programs. Two out of five (41.9%) of the states and territories offer two programs or less with

TABLE 2: Solar Courses by Organization Type and State (January 1980)

State	Organization Type					
	Colleges and Universities	Junior and Community Colleges	Vocational/ Technical Schools	Other	Total	
	#	#	#	#	#	%
Alabama	14	-	2	-	16	0.9
Alaska	1	5	-	-	6	0.3
Arizona	18	26	2	1	47	2.7
Arkansas	6	10	-	-	16	0.9
California	109	101	2	7	219	12.6
Colorado	42	40	7	4	93	5.3
Connecticut	20	3	13	-	36	2.1
Delaware	6	3	5	-	14	0.8
Washington, DC	7	-	-	1	8	0.5
Florida	17	11	3	1	32	1.8
Georgia	12	1	1	-	14	0.8
Guam	1	-	-	-	1	0.1
Hawaii	5	3	-	-	8	0.5
Idaho	9	-	-	-	9	0.5
Illinois	39	17	-	-	56	3.2
Indiana	22	2	5	-	29	1.7
Iowa	14	14	2	-	30	1.7
Kansas	31	10	-	1	42	2.4
Kentucky	6	-	-	-	6	0.3
Louisiana	6	1	-	-	7	0.4
Maine	7	1	-	7	15	0.9
Maryland	7	6	1	-	14	0.8
Massachusetts	42	9	4	2	57	3.3
Michigan	59	18	-	2	79	4.5
Minnesota	19	4	3	1	27	1.6
Mississippi	3	6	-	-	9	0.5
Missouri	31	3	1	-	35	2.0
Montana	8	4	1	1	14	0.8
Nebraska	4	2	4	-	10	0.6
Nevada	8	5	-	-	13	0.7
New Hampshire	6	-	14	2	22	1.3
New Jersey	25	4	6	-	35	2.0
New Mexico	16	1	2	-	19	1.1
New York	91	30	1	2	124	7.1
North Carolina	24	7	25	1	57	3.3
North Dakota	12	-	1	-	13	0.7
Ohio	40	4	9	3	56	3.2
Oklahoma	20	-	-	-	20	1.2
Oregon	15	7	-	-	22	1.3
Pennsylvania	36	15	4	-	55	3.2
Puerto Rico	3	1	-	-	4	0.2
Rhode Island	2	-	1	-	3	0.2
South Carolina	8	4	8	-	20	1.2
South Dakota	5	-	1	-	6	0.3
Tennessee	12	10	7	-	29	1.7
Texas	63	41	23	3	130	7.5
Utah	10	2	2	-	14	0.8
Vermont	6	3	-	1	10	0.6
Virginia	28	11	-	-	39	2.2
Washington	11	8	2	-	21	1.2
W. Virginia	4	2	-	-	6	0.3
Wisconsin	37	1	14	3	55	3.2
Wyoming	8	10	-	-	18	1.0
TOTAL	1053	468	176	43	1740	100.0
Percent	60.5	26.9	10.1	2.5	100.0	

Source: Solar Energy Research Institute

seven states and territories offering no solar program. Almost one-half (46.9%) of the total programs offered are in colleges and universities with one-third in junior and community colleges.

An analysis of solar energy degree programs by type of degree offered is shown in Table 4. It is noted initially that very few of the degree programs are found in the solar curriculum category. Only one out of ten schools offer degrees which are strictly solar in nature. Half of these degrees are at the associate level. Of the schools which offer degree programs, more than half of them offer a curriculum with solar study—where the student may emphasize solar in his/her course of study, but with a broader exposure to a specific discipline. Approximately two-thirds of these programs are offered at the bachelor's level and above, with one-third offering certificate and associate degrees. By definition, the solar technical training programs fall predominately in the certificate degree area. Without regard to program type, approximately half (51.3%) of the institutions with programs offer bachelor's degrees and above and half (48.7%) offer the certificate or associate degrees.

What types of students are trained in solar programs? Table 5 gives the distribution of student training specialization by program type. The question asked in the survey to obtain these results was: "As a result of having completed the above program, students will be trained in the following area(s)": with these training areas being listed in Table 5. It should be mentioned that this question was also interpreted as asking for the types of students enrolled in the program, rather than asking about the training experiences gained from the program. However, it is suggested that the data reflect the nature of skills in which students are being trained.

The interpretation of Table 5, because it is complex, will focus on the distribution of student training specialization without regard to program type (Solar Curriculum, Curriculum with Solar Study, Solar Technical Training as defined above). Almost one-fifth of all programs (18.4%) offer training in solar system installation techniques—both residential (12.2%) and commercial (6.2%). In a field related and necessary to system installations, solar technology—controls, design, and maintenance—is offered in another one out of eight program experiences. It is emphasized that programs may offer student specialization in a number of fields. It is, therefore, highly likely, for instance, that a program offering installation experience in the residential area will also offer a similar experience in the commercial area in addition to the solar technology experience in controls, design, and maintenance. It is noted that there are 243 programs with 787 student training specializations for an average of 3.2 specializations per program.

A further analysis of Table 5 finds one-quarter (23.8%) of the student training specializations in the academic areas of architecture, solar energy administration and policy, scientific research and development, and engineering with solar specialization. General solar energy education is offered in one out of eleven solar programs, while more than one out of 10 (10.8%) of the program specializations occur in the technical trades of electricity, plumbing, and sheet metal.

Solar Course Offering Levels

An analysis of the level on which solar courses are offered is found in Table 6. The analysis includes courses offered at the academic and non-academic level. Because courses may be offered at both an academic and non-academic level, the number of course levels reported (2,139) is greater than the number of courses (1,740).

At the academic level, it is noted that colleges and universities offer one-half (51.0%) of their programs to juniors and seniors, with one-fifth (20.6%) at the graduate level, and another one-fifth (21.3%) open to all student levels. It is not surprising, because of the nature of the institutions, that both community/junior colleges and vocational/technical schools offer courses predominantly at all levels or at the freshman/sophomore level. In total, one out of five solar courses are offered at all academic levels (20.3%), one out of seven at the graduate level (14.1%), one-third at the junior/senior level (34.4%), and another one-fifth (22.2%) at the freshman/sophomore level.

The non-academic level of course offerings have been defined to include laypersons, managers, professionals, and skilled labor. On the non-academic level, colleges and universities offer 159 courses. More than two-fifths of these (43.4%) are available to laypersons, 15.1% to managers, one-third (33.3%) to professionals, and only one out of twelve (8.2%) to skilled labor. Junior and community colleges offer a large portion of their non-academic courses to the layperson (37.2%) with another one-seventh (14.1%) to managerial persons, one-fifth to professionals (21.4%) and more than one-fourth (27.3%) to skilled labor. As might be expected, the largest course offering category in vocational/technical schools falls in the skilled labor sector where more than two-fifths of the offerings occur (42.3%).

TABLE 3: Solar Programs by Organization Type and State (January 1980)

State	Colleges and Universities	Junior and Community Colleges	Vocational/ Technical Schools	Other	Total	
	#	#	#	#	#	%
Alabama	-	-	1	-	1	0.4
Alaska	-	-	-	-		——
Arizona	3	2	2	-	7	2.9
Arkansas	2	1	-	-	3	1.2
California	12	17	1	1	31	12.7
Colorado	8	4	1	3	16	6.6
Connecticut	-	1	2	-	3	1.2
Delaware	1	1	1	-	3	1.2
Washington, DC	1	-	-	-	1	0.4
Florida	5	3	3	1	12	5.0
Georgia	-	1	-	-	1	0.4
Guam	-	-	-	-	-	——
Hawaii	-	-	-	-	-	——
Idaho	3	-	-	-	3	1.2
Illinois	5	2	-	-	7	2.9
Indiana	2	-	2	-	4	1.7
Iowa	-	4	1	-	5	2.1
Kansas	3	2	-	1	6	2.5
Kentucky	-	-	-	-	-	——
Louisiana	-	-	-	-	-	——
Maine	1	-	-	1	2	0.8
Maryland	1	-	1	-	2	0.8
Massachusetts	6	2	1	-	9	3.7
Michigan	9	-	-	-	9	3.7
Minnesota	1	-	5	1	7	2.9
Mississippi	1	2	-	-	3	1.2
Missouri	3	-	-	-	3	1.2
Montana	-	-	-	-	-	——
Nebraska	-	-	1	-	1	0.4
Nevada	1	1	-	-	2	0.8
New Hampshire	-	-	1	-	1	0.4
New Jersey	4	2	2	-	8	3.3
New Mexico	4	-	1	-	5	2.1
New York	6	5	-	-	11	4.6
North Carolina	2	2	4	-	8	3.3
North Dakota	1	-	1	-	2	0.8
Ohio	5	-	-	-	5	2.1
Oklahoma	-	-	-	-	-	——
Oregon	1	2	-	-	3	1.2
Pennsylvania	1	5	2	-	8	3.3
Puerto Rico	-	-	-	-	-	——
Rhode Island	-	-	1	-	1	0.4
South Carolina	-	-	2	-	2	0.8
South Dakota	-	-	1	-	1	0.4
Tennessee	1	4	1	-	6	2.5
Texas	9	7	1	-	17	7.0
Utah	-	1	1	-	2	0.8
Vermont	2	-	-	1	3	1.2
Virginia	4	2	-	-	6	2.5
Washington	1	1	2	-	4	1.7
W. Virginia	-	1	-	-	1	0.4
Wisconsin	4	-	1	1	6	2.5
Wyoming	1	1	-	-	2	0.8
TOTAL	114	76	43	10	243	100.0
Percent	46.9	31.3	17.7	4.1	100.0	

Source: Solar Energy Research Institute

TABLE 4: Solar Energy Degree Programs by Program Type (January 1980)

Degree Type	Solar Curriculum		Curriculum with Solar Study		Solar Technical Training		Total	
	#	%	#	%	#	%	#	%
Doctorate	2	6.2	22	12.4	0	0	24	9.0
Masters	6	18.8	46	26.0	0	0	52	19.5
Bachelors	7	21.9	53	30.0	1	1.7	61	22.8
Associate	16	50.0	34	19.2	4	6.9	54	20.2
Certificate	1	3.1	22	12.4	53	91.4	76	28.5
Total*	32	100.0	177	100.0	58	100.0	267	100.0
Total Programs	26	10.7	134	55.1	83	34.2	243	100.0

SOURCE: Solar Energy Research Institute

* Totals are greater than the number of programs (243) because schools may offer more than one degree in a program.

Student Specialization by Organization Type

Table 7 contains detailed information about student specialization topics by the various organization types, differing from Table 5 which showed student specialization topics by program type. As might be expected in the colleges and universities, the student specialization topics of greatest preponderance are in the academic areas of engineering with solar specialization (15.6%), scientific research and development (17.9%) and solar energy education (12.9%). These three areas account for almost half (46.4%) of the total specialization topics. In both the community/junior colleges and vocational/technical schools, the classroom experience is oriented toward practical solar applications. In each of these organization types, more than two-fifths of the offerings train students in the areas of heating, ventilating, and air conditioning; residential solar system installation; and solar technology—instrumentation, controls, design, and maintenance.

Course Topics Taught Extensively

The wide variety of course topics taught extensively in the 1,740 solar-related courses offered in the United States are analyzed in Tables 8 and 9. Tables 8 and 9 are identical in terms of the numerical distribution, but differ in the manner in which

TABLE 5: Student Training Specialization in Solar Programs by Program Type (January 1980)

Student Training Specialization	Solar Curriculum		Curriculum with Solar Study		Solar Technical Training		Total	
	#	%	#	%	#	%	#	%
Architecture-Solar Specialization	8	6.8	27	6.9	11	4.0	46	5.8
Solar Energy Education	11	9.4	37	9.4	22	7.9	70	8.9
Solar Energy Admin./Policy	6	5.1	13	3.3	3	1.1	22	2.8
Scientific R&D in Solar Energy	7	6.0	49	12.5	4	1.4	60	7.6
Engrg.-Solar Specialization	8	6.8	43	10.9	9	3.2	60	7.6
Mechanical/ Electrical Contracting-Solar	4	3.4	19	4.8	7	2.5	30	3.8
General Contracting-Specialization in Design/ Installation	7	6.0	17	4.3	19	6.9	43	5.5
HVAC-Solar Specialization	10	8.5	37	9.4	23	8.3	70	8.9
Solar System-Residential	14	12.0	36	9.2	46	16.6	96	12.2
Solar System Industrial/ Commercial	7	6.0	19	4.8	23	8.3	49	6.2
Solar Technology-Controls, Design, Maintenance	16	13.7	43	10.9	36	13.0	95	12.1
Electricity-Solar Specialization	5	4.3	13	3.3	13	4.7	31	3.9
Plumbing-Solar Specialization	5	4.3	12	3.1	19	6.9	36	4.6
Sheet Metal-Solar Specialization	3	2.6	5	1.3	10	3.6	18	2.3
Do-it-yourself-Home Installation	6	5.1	23	5.9	32	11.6	61	7.8
Total*	117	100.0	393	100.0	227	100.0	787	100.0
Total Programs	26	10.7	134	55.1	83	34.2	243	100.0

SOURCE: Solar Energy Research Institute

* Figures in Table will total much greater than number of programs offered because programs may offer multiple training experiences.

percentages are computed. In Table 8, one can obtain a feeling for the distribution of topics taught extensively within each organization type. For example, in colleges and universities the optics most often noted as being taught extensively are: introduction to solar energy (9.1%), heat and energy transfer (7.8%), solar heating (7.6%), and solar system design (6.8%). Table 9 allows the analysis of the distribution of each course topic by organization type. For example, in courses where satellite solar power systems is taught extensively, four out of five times it is done so at colleges and universities, with the other one-fifth occurring at the junior/community college level.

One point needs to be emphasized about Tables 8 and 9. It is noted that the classification of a course topic taught extensively is subjective in nature. There are 9,234 topics taught extensively in 1,740 courses according to the course instructors, for an average of more than 5 topics taught extensively per course. Course durations vary from two days to more than 100 contact hours, thus amplifying the subjective nature of the information. The only guideline for the classification of a topic taught extensively on the survey instrument was that it was a major course topic or concept.

Use of the Education Data Base

Numbers and statistics are interesting to some, but insufficient to others. More detailed information can be obtained about the data base in the publications already noted,[6,7,8] or by requesting special searches of data base information. For example, suppose you are an instructor wanting to learn specifically which organizations and courses are involved in teaching the topic photovoltaics and solar cells extensively at the college and university level. A specialized search could be requested from SERI which would give you a custom report based on your needs and requested information about each organization, program, and/or course. To make a request for a special data base search, write to SERI, Academic Programs, 1617 Cole Boulevard, Golden, CO 80401, or call SERI at (303) 231-1831.

CONCLUSION

The solar energy education data base should be seen as a resource tool for educators, students, administrators, curriculum developers, and others needing information relative to solar energy course, program, and curriculum offerings. Duplication of effort may be avoided. In addition, the sharing of information

TABLE 6: Course Offering Levels in Solar Courses by Organization Type (January 1980)

Course Offering Level	Colleges and Universities		Junior and Community Colleges		Vocational/ Technical Schools		Other		Total	
	#	%	#	%	#	%	#	%	#	
Academic Levels:										
All Levels	209	21.3	174	43.0	43	43.9	16	64.0	442	
College Graduate	202	20.6	3	0.7	1	1.0	6	24.0	212	
College Junior/Senior	500	51.0	16	3.9	1	1.0	2	8.0	519	
College Freshman/Sophomore	69	7.1	212	52.4	53	54.1	1	4.0	335	
TOTAL*	980	100.0	405	100.0	98	100.0	25	100.0	1508	1
Non-Academic Levels:										
Layperson	69	43.4	132	37.2	18	25.4	19	41.3	238	
Managerial	24	15.1	50	14.1	6	8.4	5	10.9	85	
Professional	53	33.3	76	21.4	17	23.9	13	28.3	159	
Skilled Labor	13	8.2	97	27.3	30	42.3	9	19.6	149	
TOTAL*	159	100.0	355	100.0	71	100.0	46	100.0	631	1
Grand Total*	1139		760		169		71		2139	
Percent		53.3		35.5		7.9		3.3		1

Source: Solar Energy Research Institute

*Because courses may be offered at several levels, the totals will be greater than the individual number of courses offered.

TABLE 7: Student Specialization in Solar Programs by Organization Type (January 1980)

Student Specialization	Colleges and Universities		Junior and Community Colleges		Vocational/ Technical Schools		Other		Total	
	#	%	#	%	#	%	#	%	#	
Architecture-Solar Specialization	23	7.6	14	5.2	6	3.5	2	5.0	45	5
Do-it-yourself/Home Installation	17	5.6	25	9.3	14	8.2	5	12.5	61	7
Electricity-Solar Specialization	8	2.6	12	4.4	9	5.3	2	5.0	31	4
Engineering-Solar Specialization	47	15.6	7	2.6	3	1.8	3	7.5	60	7
General Contracting-Specialization in Solar Design/Installation	10	3.3	17	6.3	12	7.0	4	10.0	43	5
Heating, Ventilation, Air Conditioning-Solar Specialization	20	6.6	30	11.1	19	11.1	—	—	69	8
Mechanical/Electrical Contracting-Solar Specialization	10	3.3	10	3.7	10	5.8	—	—	30	3
Plumbing-Solar Specialization	5	1.7	15	5.5	12	7.0	3	7.5	35	4
Scientific Research and Development in Solar Energy	54	17.9	5	1.9	1	0.6	—	—	60	7
Sheet Metal-Solar Specialization	2	0.7	9	3.3	4	2.3	2	5.0	17	2
Solar Energy Administration/Policy	15	5.0	5	1.9	2	1.2	—	—	22	2
Solar Energy Education	39	12.9	17	6.3	12	7.0	2	5.0	70	8
Solar System Installation-Industrial/Commercial	8	2.6	20	7.4	17	9.9	4	10.0	49	6
Solar System Installation-Residential	18	6.0	44	16.3	27	15.8	7	17.5	96	12
Solar Technology-Instrumentation, Controls, Design, Maintenance	26	8.6	40	14.8	23	13.5	6	15.0	95	12
TOTALS*	302	100.0	270	100.0	171	100.0	40	100.0	783	100

Source: Solar Energy Research Institute

*Because programs may have several student specializations coded, the number of entries (783) will be greater than the individual number of programs (243).

TABLE 8: Number of Times Topics are Taught Extensively in Solar Courses by Organization Type (January 1980)

Course Topics	Organization Type: Colleges and Universities		Junior and Community Colleges		Vocational/ Technical Schools		Other		Total
	#	%	#	%	#	%	#	%	#
Alternate Energy Sources	334	6.2	114	4.2	30	3.2	6	3.0	484
Appropriate Technology	204	3.8	84	3.1	26	2.8	10	5.1	324
Bioconversion	57	1.1	26	1.0	3	0.3	--	---	86
Centralized Solar Power Systems	90	1.7	29	1.1	11	1.2	--	---	130
Components-Solar	311	5.8	188	7.0	71	7.6	21	10.6	591
Distributed Solar Power Systems	91	1.7	43	1.6	14	1.5	3	1.5	151
Energy Conservation	338	6.2	155	5.8	42	4.5	10	5.1	545
Energy Storage Systems	306	5.7	173	6.4	56	6.0	10	5.1	545
Greenhouse Techniques	53	1.0	31	1.1	16	1.7	11	5.6	111
Heat and Energy Transfer	424	7.8	174	6.5	58	6.2	10	5.1	666
Hybrid Systems	40	0.7	35	1.3	8	0.9	1	0.5	84
Introduction to Solar Energy	494	9.1	182	6.8	70	7.5	12	6.1	758
Materials	93	1.7	70	2.6	27	2.9	10	5.1	200
Ocean Systems	16	0.3	8	0.3	1	0.1	--	---	25
Passive Solar Systems	285	5.3	108	4.0	36	3.9	20	10.1	449
Photoconversion	45	0.8	12	0.4	4	0.4	1	0.5	62
Photovoltaics & Solar Cells	139	2.6	33	1.2	8	0.9	--	---	180
Plumbing Techniques	39	0.7	72	2.7	40	4.3	3	1.5	154
Process Heat	47	0.9	17	0.6	13	1.4	1	0.5	78

TABLE 8: (Cont.)

Course Topics	Organization Type Colleges and Universities		Junior and Community Colleges		Vocational/Technical Schools		Other		Total	
Satellite Solar Power Systems	13	0.2	3	0.1	--	---	--	---	16	
Sheet Metal Techniques	10	0.2	22	0.8	17	1.8	--	---	49	
Solar Cooling	147	2.7	62	2.3	19	2.0	1	0.5	229	
Solar Domestic Hot Water	307	5.7	179	6.6	61	6.6	7	3.5	554	
Solar Energy Policy Development	67	1.2	13	0.5	6	0.7	1	0.5	87	
Solar Heating	410	7.6	204	7.6	70	7.5	22	11.1	706	
Solar Home Construction	132	2.4	97	3.6	27	2.9	13	6.5	269	
Solar Law/Legislation	34	0.6	18	0.7	4	0.4	--	---	56	
Solar Marketing/Economic Analysis	148	2.7	67	2.5	19	2.0	2	1.0	236	
Solar Swimming Pool Heating	40	0.7	50	1.9	13	1.4	--	---	103	
Solar System Design	370	6.8	174	6.5	69	7.4	13	6.5	626	
Solar System Installation/Maintenance	78	1.4	122	4.5	57	6.1	5	2.5	262	
Solar System Testing/Evaluation	112	2.1	84	3.1	25	2.7	3	1.5	224	
Thermochemical Conversion	20	0.4	6	0.2	1	0.1	--	---	27	
Wind Energy Conversion Systems	117	2.2	38	1.4	10	1.1	2	1.0	167	
TOTAL *	5411	100.0	2693	100.0	932	100.0	198	100.0	9234	1

Source: Solar Energy Research Institute

*Because courses may offer a variety of topics taught extensively, the number of topics (9234) will be much greater than the individual courses offered (1740).

TABLE 9: Number of Times Topics are Taught Extensively in Solar Courses by Organization Type (January 1980)

Course Topics	Organization Type: Colleges and Universities #	Colleges and Universities %	Junior and Community Colleges #	Junior and Community Colleges %	Vocational/ Technical Schools #	Vocational/ Technical Schools %	Other #	Other %	Total #	Total %
Alternate Energy Sources	334	69.0	114	23.6	30	6.2	6	1.2	484	100.0
Appropriate Technology	204	63.0	84	25.9	26	8.0	10	3.1	324	100.0
Bioconversion	57	66.3	26	30.2	3	3.5	--	---	86	100.0
Centralized Solar Power Systems	90	69.2	29	22.3	11	8.5	--	---	130	100.0
Components-Solar	311	52.6	188	31.8	71	12.0	21	3.6	591	100.0
Distributed Solar Power Systems	91	60.2	43	28.5	14	9.3	3	2.0	151	100.0
Energy Conservation	338	62.0	155	28.5	42	7.7	10	1.8	545	100.0
Energy Storage Systems	306	56.2	173	31.7	56	10.3	10	1.8	545	100.0
Greenhouse Techniques	53	47.8	31	27.9	16	14.4	11	9.9	111	100.0
Heat and Energy Transfer	424	63.7	174	26.1	58	8.7	10	1.5	666	100.0
Hybrid Systems	40	47.6	35	41.7	8	9.5	1	1.2	84	100.0
Intro. to Solar Energy	494	65.2	182	24.0	70	9.2	12	1.6	758	100.0
Materials	93	46.5	70	35.0	27	13.5	10	5.0	200	100.0
Ocean Systems	16	64.0	8	32.0	1	4.0	--	---	25	100.0
Passive Solar Systems	285	63.5	108	24.0	36	8.0	20	4.5	449	100.0
Photoconversion	45	72.6	12	19.4	4	6.4	1	1.6	62	100.0
Photovoltaics & Solar Cells	139	77.2	33	18.3	8	4.5	--	---	180	100.0
Plumbing Techniques	39	25.3	72	46.8	40	26.0	3	1.9	154	100.0
Process Heat	47	60.2	17	21.8	13	16.7	1	1.3	78	100.0
Satellite Solar Power Systems	13	81.2	3	18.8	--	---	--	---	16	100.0

TABLE 9: (Cont.)

	Organization Type									
Course Topics	Colleges and Universities		Junior and Community Colleges		Vocational/ Technical Schools		Other		Total	
Sheet Metal Techniques	10	20.4	22	44.9	17	34.7	--	---	49	100.0
Solar Cooling	147	64.2	62	27.1	19	8.3	1	0.4	229	100.0
Solar Domestic Hot Water	307	55.4	179	32.3	61	11.0	7	1.3	554	100.0
Solar Energy Policy Development	67	77.0	13	14.9	6	6.9	1	1.2	87	100.0
Solar Heating	410	58.1	204	28.9	70	9.9	22	3.1	706	100.0
Solar Home Construction	132	49.1	97	36.1	27	10.0	13	4.8	269	100.0
Solar Law/Legislation	34	60.7	18	32.2	4	7.1	--	---	56	100.0
Solar Marketing/Economic Analysis	148	62.7	67	28.4	19	8.1	2	0.8	236	100.0
Solar Swimming Pool Heating	40	38.8	50	48.6	13	12.6	--	---	103	100.0
Solar System Design	370	59.1	174	27.8	69	11.0	13	2.1	626	100.0
Solar System Installation/Maint.	78	29.8	122	46.6	57	21.7	5	1.9	262	100.0
Solar System Testing/Evaluation	112	50.0	84	37.5	25	11.2	3	1.3	224	100.0
Thermochemical Conversion	20	74.1	6	22.2	1	3.7	--	---	27	100.0
Wind Energy Conversion Systems	117	70.1	38	22.7	10	6.0	2	1.2	167	100.0
TOTAL*	5411	58.6	2693	29.2	932	10.1	198	2.1	9234	100.0

Source: Solar Energy Research Institute

*Because courses may offer a variety of topics taught extensively, the number of topics (9234) will be much greater than the individual courses offered (1740).

may lead to better, more suitable course offerings, especially as solar develops toward commercial feasibility in a variety of new fields such as wind energy conversion systems, passive technology, and photovoltaics. It is anticipated that the data base will facilitate the sharing of progress and problems by those with similar interests, in addition to pointing students to educational institutions offering programs to meet their needs.

REFERENCES

1. *Solar Energy Domestic Policy Review, Appendix: Labor Impacts of Solar Energy Development*. Reports to the Impacts Panel by the Employment Impact Task Force, September 21, 1978.
2. Schacter, Meg. *The Job Creation Potential of Solar and Conservation: A Critical Evaluation*, Policy and Evaluation Office, Department of Energy, November 6, 1979 (mimeo).
3. Mason, Bert. *Labor Manpower and Training Requirements—Technical Progress Report*. Golden, CO: Solar Energy Research Institute. SERI/PR-53-073; September 1978.
4. Burns, Barbara A. et al. *Beyond the Body Count: The Qualitative Aspects of Solar Energy Employment*. Golden, CO: Solar Energy Research Institute. SERI/RR-354-395 (In Draft/Review Form only as of February 1980).
5. O'Connor, Kevin. *Solar Energy Task Force Report—Technical Training Guidelines*. Golden, CO: Solar Energy Research Institute. SERI/SP-42-345; October 1979.
6. Corcoleotes, G. et al. *National Solar Energy Education Directory*, 1st Edition. Golden, CO: Solar Energy Research Institute. SERI/SP-42-141; January 1979.
7. Corcoleotes, G. et al. *National Solar Energy Education Directory*, 2nd Edition. Golden, CO: Solar Energy Research Institute. SERI/SP-401-516; March 1980.
8. Corcoleotes, et al. *Solar Energy Technical Training Directory*. Golden, CO: Solar Energy Research Institute. SERI/SP-84-282; June 1979.

Workforce Training Implications of an Empirical Survey of Energy Curricula

Ethel Simon-McWilliams, Northwest Regional Educational Laboratory, Portland, Oregon

INTRODUCTION

It is said that energy, by most of us, has been treated like air. Excellent selling jobs over the years by power-generating utilities and power-consuming industries have led us to think and to behave as if energy were an endlessly consumable resource. Our schools and classrooms have reflected this belief in the past in both their architectural designs and instructional content. Recently, the rising cost of imported oil and other energy sources has startled the American consumer and producer into examining the state of their energy sources. Thus, conservation programs have been initiated. Even with maximum conversation efforts, most predictors report that new sources of energy will be required in the future. While today we talk about energy conservation and about the production of more energy from conventional or alternative sources, few actually have enough knowledge and skill to participate in such endeavors.

To make our nation more aware of the implications of energy policy, specifically as it relates to energy and energy related workforce needs, a strong educational program is required. Therefore, it appears to be essential that schools include energy education as an integral part of their curricular efforts.

PEECE

An indepth knowledge and understanding is absolutely necessary if intelligent decisions are to be made within this area. To this end, individuals representing the Pacific Northwest's state energy offices and state education agencies formed a group called Project for Energy: Energy Conservation Education, known as PEECE. The group seeks to provide for a coordinated effort in the development and dissemination of energy education materials. With funding from the Bonneville Power Administration (BPA), PEECE contracted with the Northwest Regional

Educational Laboratory (NWREL), to conduct a survey to determine 1) energy education programs currently available to school districts, 2) energy education programs being developed, and 3) areas where additional material development efforts are required. The survey was conducted in Idaho, western Montana, Oregon, and Washington. (The area served by the Bonneville Power Administration was to be surveyed; thus only western Montana was included.) This study does not represent a comprehensive assessment of all resources in the field—rather it is an initial stage in the development of such an effort. Each school district in these states received a survey instrument. State participation varied greatly. Of the total 1,120 instruments mailed out, 438 or 39.1 percent were returned. Because of time and financial constraints, followup efforts were not initiated to increase the number of returns. (Response combinations to the questions, "Does your district currently offer energy education programs?" and "Does your district have a need for additional energy education materials?" can be seen in Table 1.) Nearly half, or 42.2 percent of the respondents, indicated that they currently have energy education programs and would like additional materials. Another 34 percent indicated that they did not currently have energy education programs but would like materials. Thus, more than three-fourths of the districts expressed a need for materials. Only 11.9 percent of the districts responding to the survey indicated that they did not have energy education programs and felt that such programs were not necessary, thus materials were not needed.

Of the districts having programs, 94.6 percent indicated some type of program for students while 52.5 percent indicated that they offer some type of training program for teachers. (Program audiences for district energy education programs can be seen in Table 2.)

Respondents were also asked to indicate the audiences for which the identification or development of additional materials was most needed. As with the programs in use, additional materials for administrators, classified staff and board members were not considered very important. Eighty-six (86) percent of the respondents expressed a need for additional materials for students and 75 percent indicated a need for additional materials for teachers. (See Table 3 for responses.)

Most of the current programs identified were at the lower and middle elementary grades and, similarly, most requests for additional materials were for these same grade levels. (See Tables 4, 5, 6 and 7.)

TABLE 1: Answer Combinations for Question #1

Answer Combination	Number of Districts	Percent of Responses
Yes/Yes	185	42.2
Yes/No	23	5.2
No/Yes	149	34.0
No/No	52	11.9
No/—	4	0.9
Yes/—	15	3.4
—/No	0	0.0
—/Yes	10	2.3
—/—	0	0.0

TABLE 2: Program Audience for District Energy Education Programs

Program Audience	*Number of Districts	Percent of Districts
Teachers	117	52.5
Administrators	52	23.2
Board Members	16	7.2
Students	211	94.6
Classified Staff	65	29.1

* Totals equal more than 100% because many districts are offering programs to more than one of the audiences listed above.

TABLE 3: Audiences for Which Additional Materials Were Requested

Program Audience	Number of Districts	Percent of Districts
Teachers	258	75.0
Administrators	136	39.5
Board Members	82	23.8
Students	296	86.0
Classified Staff	102	29.6

As can be seen in Table 8, physical science and social studies were the two curricular areas where most indicated a need for additional materials. Since physical science and social studies are the areas for which most materials have already been developed, respondents may have been more aware of specific gaps in materials for those areas. Curricular areas such as health education where few energy education materials exist at the present time may not have been considered. It was interesting to note that 108 respondents or approximately 25 percent felt that energy education curriculum materials were needed in career education.

Many of the districts seemed to rely on materials developed "in-house." As would be expected, examination across districts of materials developed in-house revealed that efforts were highly duplicative. The National Science Teachers Association, Energy and Man's Environment, the Pacific Power and Light Company, Portland General Electric Company, and the Federal Energy Administration were those outside agencies from which materials were most frequently obtained.

TABLE 4: Grade Level of Current Energy Education Materials by grade range

Grade Level	Number of Responses
K-6	127
7&8	118
9-12	98
Community College	2

TABLE 5: Grade Level of Current Energy Education Materials by grade level

Grade Level	Number of Responses
K	6
1	13
2	15
3	17
4	25
5	29
6	32
7	28
8	26
9	16
10	8
11	8
12	8
Community College	0

TABLE 6: Grade Level of Needed Energy Education Materials by grade range

Grade Level	Number of Responses
K-6	123
7&8	116
9-12	104
Community College	4

TABLE 7: Grade Level of Needed Energy Education Materials by grade level

Grade Level	Number of Responses
K	66
1	82
2	85
3	91
4	99
5	104
6	109
7	108
8	109
9	80
10	64
11	64
12	62
Community College	3

TABLE 8

Curriculum Area	Number of Responses
Physical Science	255
Biological Science	123
Math	68
Social Studies	205
Economics	134
Career Education	108
Health Education	66

A review of the materials being utilized by the responding school districts showed that none of the materials dealt directly with energy careers or career awareness. However, two of the organizations from which materials were purchased—the National Science Teachers Association and Energy and Man's Environment—indicated that though they do not produce a specific career awareness package, they felt career information is contained within their materials as necessary.

Study Conclusions

The NWREL study concludes with the following four (4) recommendations:

1. There is a need for a coordinating institution to serve as a clearinghouse—certainly in cooperation with the existing network of ERIC clearinghouses around the nation—to identify, acquire if possible, validate and disseminate information about materials that have already been developed for use in schools. In addition, this clearinghouse

could assist with the collection and dissemination of the energy education materials developed at the local school level. Since the NWREL study was conducted, some effort has been initiated to collect and disseminate data related to energy, but it is shrouded under the rubric of Environmental Education.

2. Materials that are developed should be incorporated or infused into existing curricular areas and not independent of these existing areas.
3. Because school districts have different needs, the principal effort should be directed toward developing a knowledge base and skill level at the district level so that local teachers and administrators will have the capacity to select and incorporate materials into their existing curricula in such a way as to foster an interdisciplinary energy consciousness.
4. Materials that are developed in the future for use in the Northwest, and perhaps in other areas, should be so designed that the content can be infused into existing curricula areas where additional materials were requested in this study; that is, in areas such as social studies and physical science. Materials should also be targeted toward the audiences identified as needing additional materials. It must be understood that materials alone do not a program make. Thus, it is imperative that curriculum designers and textbook publishers be influenced to assist in this infusion effort since most educators still look to textbooks as the core for a program.

The Northwest Energy Education Survey highlights two important factors. Firstly, it is necessary to define the role and responsibilities of the elementary and secondary schools in providing programs to create a more energy conscious populace. Secondly, it is necessary to recognize that there is a significant lack of materials aimed at energy career awareness—thus creating far-reaching implications for future workforce needs. Before the market is saturated with materials, the role of the elementary and secondary schools in career awareness and the job training process should be defined. As with other careers or vocations, perhaps the elementary and secondary energy curriculum should be limited to creating an awareness of energy career opportunities. Or, as it is stated in Copa and Irwin's *Occupational Supply and Demand Information: A Format for Planning Education for Work,* the curriculum should provide awareness, orientation, exploration or preparation while at the same time, basic skills necessary for success in on-the-job training should be developed. It should be noted that according to several agencies in the Northwest, the single most frequently used source of training for today's positions in the energy field is on-the-job coupled with classroom instruction afforded by community colleges. Content for instruction is based on the occupational training needs determined by company training officials. This allows implications to be drawn, as those drawn by Copa and Irwin, for training programs at the adult level since it is evident that these individuals had little, if any, awareness of energy workforce needs prior to entering the job market. That is, training will be necessary for those who wish to change to energy or energy-related jobs and for those needing updating to keep their jobs or reenter the workforce.

Identifying Existing Materials

To identify existing energy career awareness materials, beyond the few cited by the responding school districts, a targeted computer search was conducted of the 1978-79 holding of the Educational Resource Information Center System (ERIC). Five out of sixteen clearinghouses in this system reported energy career education or integrated energy education materials. From this search only three documents were found to provide energy career information either for students or for use by teachers in preparing such programs. The three documents are: *Energy Related Careers* developed at Texas A&M University, *Professional Energy Careers* prepared by the Department of Energy, and Richard Grossman's *Guide to Jobs and Energy*. In addition, there is the Bureau of•Labor Statistics *Occupations Outlook Handbook* which reveals some information about projected energy related jobs through 1985. From this meager return we can draw some possible conclusions:

1. Few energy career awareness materials exist.
2. If they exist, they have not been identified and collected.
3. It has not been a priority of clearinghouses to identify and collect energy-related materials.
4. Materials exist and have been judged of less than good quality.

Before being able to confirm any of these conclusions, we need to know: 1) how extensively is the ERIC system focusing on energy materials identification, evaluation and collection, and 2) how extensive is the financial support and time for the creation of such materials by individuals or groups who have something worthy to contribute?

Industry Projections

Utility companies, it appears, are still having difficulty believing that both the generation and the conservation of energy can create jobs. Hence, when asked about projections of employment needs for the future, their replies are mixed. Contact with two utility companies headquartered in the Portland area revealed that both firms expect increases in employment in the future as additional generating capacities develop. Neither, however, has made specific projections as to the number of workers in any field that will be required. As stated in *Towards Better Methods of Labor Market Analysis for Educational and Training Program Planning* edited by Thomas W. McClain, "It is necessary to understand and utilize labor market processes in order to improve vocational education planning." That is, forecasting models which include demand and supply information, sufficient job details and clarify technology considerations should be applied to the energy and energy-related workforce. This information, if it is to be used, has to be presented in a succinct nonvoluminous manner—not as a 50 state/50 volume report that is now in the ERIC system, *Manpower Needs and Programs*.

School Role—Critical

Energy education for conservation and effective utilization becomes more important as we strive to create an energy literate populace. The role of the school is critical. Elementary and secondary schools *are* capable of educating, of changing attitudes. They can create awareness or provide basic training skills which lead to more effective on-the-job or college training. How will we train our educators to train for energy literacy? How will we change the attitudes of our community leaders as was done in Davis, California? Their focus was the conservation of energy direction being given by three (3) community leaders. Solar power became important as a means of heating and cooling in 2,000 homes. Bicycles replaced cars with 27,000 licensed bicycles compared to 12,188 registered cars.

Who are the new groups who will take responsibility for creating instructional materials and processes that support the principles of a conserving populace? Energy career awareness can come from many sources—from modeling respected adults, from observing, from thoughtful teaching, from inner goals created from who-knows-what influences. We choose our careers from our own sense of goals and values. But in order to choose, we must have information on choices we have opportunities to make. Materials are few as are effective programs. Workforce training implications of the Northwest Regional Educational Laboratory's Empirical Survey of Energy Curricula are far-reaching. To address them it will take a vast supply of "energy" and a small amount of *money*.

BIBLIOGRAPHY

1. Allen, Jack and Larry Picus. *Northwest Energy Education Survey* (NWREL: Portland, OR) Feb. 1979, 83 pages.
2. Center for Career Development, College of Education, Texas A and M University, *Energy Related Careers*. (College Station: Texas A and M University, 1978) 37 pages. (ED 167 414)
3. United States Department of Energy. *Professional Energy Careers*. (Washington, D.C.: Department of Energy, Office of Public Affairs, 1979) 48 pages. (ED 173 121)
4. Grossman, Richard and Gail Daneker. *Guide to Jobs and Energy* (Washington, D.C.: Environmentalists for Full Employment, Jan. 1978) 25 pages. (ED 166 208)
5. Bureau of Labor Statistics. *Energy Producing Industries: Reprinted From the Occupational Outlook Handbook, 1978-79 Edition*. (Washington, D.C.: Bureau of Labor Statistics, Department of Labor, 1978) 25 pages. (ED 158 141)
6. Wawasee Area Vocational Cooperative. *Oil and Gas Task Force Report Draft Copy*. (Syracuse Indiana Wawasee Area Vocational Cooperative, 1979) 20 pages. (ED 173 120)
   Wawasee Area Vocational Cooperative. *Coal Task Force Report on Education and Training: Draft Copy*. (Syracuse Indiana Wawasee Area Vocational Cooperative, 1979) 219 pages. (ED 173 119)
7. Pacific Power and Light Company. *The Road to Your Future*. (Portland; Pacific Power and Light Company, 1979) 30 pages.
8. Copa, George H. and Donald Irvin. *Occupational Supply and Demand: A Format with Implications for Planning Education for Work*. (Minnesota Research Coordinating Unit for Vocational Education: Minneapolis, Minnesota, Sept. 1979) 86 pages. (ED 159 425)
9. McClain, Thomas W. Ed. *Towards Better Methods of Labor Market Analysis for Educational and Training Program Planning*. (Massachusetts State Department of Education, Boston, Massachusetts, Sept. 1977) 45 pages. (ED 159 321)
10. National Environmental/Energy Workforce Assessment, Phase II, Post Secondary Education Profile. *Energy*. (National Field Research Center Inc., Iowa City, 1978) 347 pages. (ED 161 735)
    National Environmental/Energy Workforce Assessment, Phase II, Post Secondary Education Profile. *Abstract*. (National Field Research Center, Inc., Iowa City, Iowa, 1978) 52 pages. (ED 161 731)
11. Energy. A Guide to Organizations and Information Resources in the U.S. Second Ed. Who's doing what series: 1. (Claremont, California: Center for California Public Affairs, 1978). 214 pages. (ED 167 377)

12. Askin, Ralph J. and others. *California School Energy Concepts, 1978.* (Sacramento, California: California State Department of Education, Bureau of School Planning, 1978.) 49 pages. (ED 167 341) Project designed to promote energy conservation in California schools.
13. Elvin, Betty and others. *Texas Energy Education Framework: A Pilot Draft*. (Austin, Texas: Texas Education Agency, 1978.) 28 pages. (ED 166 032) Framework for K-12 energy education in Texas.
14. Buethe, Chris. Energy in Your Curriculum. *Educational Leadership.* (Volume 37, N. 2, November 1979.) pp. 162-164.
15. National Science Teachers Association. *Energy and Education* (Washington, D.C. Volume 3 No. 2 Dec. 1979)
16. Thompson, Dick. "Where Everyone's a Wheel" *Parade*. Feb. 3, 1980 Page 5.

Counseling for Career Opportunities in Energy-Related Industries

Mayme R. Crowell and John R. Doggette, Oak Ridge Associated Universities, Oak Ridge, Tennessee

INTRODUCTION

Career opportunities in energy-related industries exist. However, the complexity of the job market situation in these industries requires careful, calculated considerations of both economic conditions and of individual skills necessary for entry-level employment and subsequent job advancement. Not only must the individual's abilities, interests, and skills be assessed, but also the climate and conditions of the local, regional, and national labor markets must be accurately analyzed and, in some cases, even predicted.

This paper addresses the specific informational needs of counselors. It establishes parameters within which energy-related jobs and industries can be analyzed. It emphasizes and analyzes problems encountered in interpreting and applying available published data.

The plethora of job titles and the maze of career opportunities both within and between respective energy-related industries creates confusion for many new entrants to the labor force, as well as for early and mid-life career changers. The school counselor and the professional career counselor, regardless of what their theoretical orientations may be, have the responsibility to appraise available labor force and job data, to assess each client's stated goals, and to provide appropriate, realistic information to help the client in the decision-making process of career selection.[1]

To the credit of the nation's educational system, energy information has penetrated traditional curricula. In addition, public media bombard students with programs, advertisements, and public announcements concerning energy, particularly energy conservation. On television Gregory Peck hold a lighted candle and warns the public not to "blow it." News programs provide short energy scenarios. Mobil Oil publishes and televises their "energy fables." When considering careers, students naturally think of what they have seen, heard, or perhaps read. The conglomeritic word "energy" often permeates their thoughts as they discuss career plans. The knowledgeable, skillful counselor can help transform youthful enthusiasm and concern for energy into specific career orientations.

Career counseling is not a simple task, however. In recognition of this fact, the American Personnel and Guidance Association recently conducted a two-year comprehensive study on the involvement of the school counselor in career education. This report, *The School Counselor and Career Education*, emphasizes the information needs of both students and counselors, suggests avenues for minimizing the present dual delivery systems from school counselors and local employment services, and encourages collaboration between schools, businesses, and the community.[1]

Counseling for career opportunities in energy-related industries, in particular, requires stalwart interest, astute awareness, and additional knowledge on the part of the school counselor. The counselor needs specific information, especially designed for the student, about emerging energy technologies as well as about traditional energy sources. The counselor must recognize energy-related job possibilities and the career advancement relationships within all existing industries. The counselor also must assess the local situation as well as the national trends. To date, however, a paucity of published energy-related occupational information to aid the school and professional career counselor exists.

Seven energy-related industries are briefly highlighted. These include the traditional energy sources of coal, oil and gas, and nuclear. Solar and other energy sources such as wind, geothermal, and biomass are discussed separately. Energy conservation, which includes energy generation and transmission, and the energy plant construction industry complete the picture of specific energy-related industries. Concluding this presentation are summary remarks providing recommendations and implications for counseling for career opportunities in energy-related industries.

Existing Information and Oak Ridge Associated Universities' Involvement

Although the national energy policy never has been, and probably never will be, static and although disagreement exists over the net effect of energy policies and laws, the 1978 National Energy Act and the Second National Energy Plan assure certain trends. The shift from oil and gas to coal and other energy sources will result in a reallocation of labor demands and in a significant change in capital construction activity.[3] Predominant energy sources will continue to be gas, oil, and coal; while nuclear energy and alternative energy-sources will increase significantly but remain only a small portion of the total energy source mix. One projection of the future energy source mix from 1977 to 1995 appears in Table 1. In addition, national energy needs will assuredly increase. The Second National Energy Plan projects domestic production of energy to increase from 60 quads in 1975 to between 97 and 113 quads in the year 2000.[4] A well-trained and flexible labor force will be needed to support both this enlarged energy supply and the constantly changing energy source mix.

TABLE 1: Percent Distribution of Primary Energy Sources

Energy Source	1977 (Percent)	1985 (Percent)	1990 (Percent)	1995 (Percent)
Coal	**19.98**	**24.72**	**30.13**	**35.55**
Gas	**25.83**	**21.87**	**18.75**	**15.90**
Oil	**47.76**	**42.72**	**38.64**	**34.37**
Nuclear	**3.39**	**7.16**	**9.10**	**10.79**
Other	**3.04**	**3.53**	**3.37**	**3.38**
Total	**100.00**	**100.00**	**99.99**	**99.99**

Source: Adapted from Energy Information Administration, *Energy Supply and Demand in the Midterm*, Department of Energy, April, 1979.

For the past six years, Oak Ridge Associated Universities (ORAU), as a prime contractor to the U.S. Department of Energy, has assessed and researched existing and emerging energy technologies. As an integral part of its research activities, ORAU has been in frequent contact with most of the nation's suppliers of entry-level technicians in energy-related industries. In 1976, John Doggette conducted a survey in cooperation with the American Association of Community and Junior Colleges locating energy-related technology programs in the nation's community and junior colleges.[5] In 1978, Mayme Crowell conducted a telephone survey among the two-year postsecondary vocational-technical institutions in the United States to locate energy-related programs and activities.[6] An update of the two studies appeared in the January, 1979 American Vocational Journal *VocEd* article entitled, "Technicians: Where Do We

Stand?"[7] In November 1979, Wayne Stevenson and John Doggette co-authored "Energy-Related Employment and Vocational Education During the 1980s."[8] ORAU also has conducted and published extensive labor force studies in the coal,[9] nuclear,[10] and solar industries.[11] These surveys, articles and labor market studies, along with visits to training sites and participation in conferences on energy-related jobs, have enabled ORAU staff members to gain expertise about jobs and energy.

ORAU remains in contact with other groups that collect information about energy-related education and training. These include the American Association of Community and Junior Colleges, the American Vocational Association, the Solar Energy Research Institute, and the Technical Education Research Center—Southwest. Reports from these organizations, along with ORAU's surveys, provide practical information about available training for jobs in energy-related industries, but they do not purport to assess placement of energy-related training graduates and/or their subsequent career advancement.[12,13]

Relevant information about job availability in specific energy-related industries is available from various sources. Regional solar centers, as well as the Solar Energy Research Institute (SERI) at Golden, Colorado provide current data on both solar training and solar jobs. The Atomic Industrial Forum and the Edison Electric Institute publish information about nuclear and electric power plant jobs. The American Petroleum Institute and the National Petroleum Refiners Association describe jobs and career development in the oil and gas industries. A 24-page bulletin, *Energy-Producing Industries*, has been compiled by the Bureau of Labor Statistics from the 1978–79 edition of *The Occupational Outlook Handbook*.[14] Included are occupations in coal mining, the electric power industry, nuclear energy, and petroleum and natural gas. Although jobs for these traditional energy-related industries are well documented, other newer energy-related industries are not mentioned.

One comprehensive book describing career opportunities in energy-related industries is John Woodburn's *Opportunities in Energy Careers*.[15] This book contains chapters on all energy-related industries. Although training programs are not listed, excellent job descriptions appear and numerous labor force studies are cited. Woodburn removes the mystique from the word "energy" and describes the growing need for competent professionals and support workers in each of the various energy industries. Woodburn summarizes coal, oil, nuclear energy, solar, and power plant jobs. His combined listings appear in Table 2. Jobs in Energy-Related Industries.

TABLE 2: Jobs in Energy-Related Industries

COAL INDUSTRY JOBS

Engineers and Scientists

(Generally requires a four-year Bachelor's degree and may require additional postgraduate study)

mining engineers
civil engineers
geologists
geophysicists
analytical chemists
environmental engineers
mine safety inspectors
coal gasification engineers

Support Workers

(Generally requires at least a two-year Associate degree for technicians; technologists require a four-year Bachelor's degree)

engineering technicians
engineering technologists
laboratory technicians

Blue Collar Workers

(Generally requires on-the-job training or an apprenticeship following a high school education)

mine workers (drilling machine operators; roof bolters; etc.)

Semiskilled Workers

(May require high school education)

miner's assistants
laborers
truck drivers

OIL INDUSTRY JOBS

Engineers and Scientists

(Generally requires a four-year Bachelor's degree, but may require postgraduate study)

petroleum engineers
environmental engineers
chemical engineers
chemists
geologists
geophysicists

Support Workers

(Generally requires at least two-year Associate degree for technicians; technologists require a four-year Bachelor's degree)

engineering technicians
engineering technologists
laboratory technicians

Blue Collar Workers

(Generally requires an apprenticeship)

welders
ironworkers
oil well drillers

Semiskilled Jobs

(May require a high school education)

truck drivers
equipment operators
laborers (roughnecks)

NUCLEAR ENERGY JOBS

Engineers and Scientists

(Generally requires a four-year Bachelor's degree and often requires post-graduate study)

nuclear engineers
radiation chemists
nuclear physicists
health physicists
electrical engineers
mathematicians
radiological physicists
radiological chemists

Support Workers

(Generally requires at least a two-year Associate degree and may require a four-year Bachelor's degree)

radiation monitors
nuclear reactor operators
accelerator operators
radiographers
radioisotope-production operators
hot-cell technicians
decontamination workers
waste-treatment operators
waste disposal workers
quality control technicians

Blue Collar Workers

(Generally requires apprenticeship)

pipefitters
electricians
carpenters
welders
sheet metal workers
boilermakers
bricklayers
painters

Semiskilled Workers

(May require high school education)

maintenance workers
laborers
messengers

TABLE 2: (cont.)

SOLAR ENERGY JOBS

Engineers and Scientists

(Generally requires a four-year Bachelor's degree and may require additional postgraduate study)

- solar engineers
- electrical engineers
- design engineers
- architects
- environmental engineers
- civil engineers

Support Workers

(Generally requires at least a two-year Associate degree for technicians; technologists require a four-year Bachelor's degree)

- architectural technicians
- engineering technologists

Blue Collar Workers

(Generally requires apprenticeship)

- sheet metal workers
- plumbers
- electricians
- ironworkers
- welders

Semiskilled Workers

(May require high school education)

- laborers
- equipment operators

POWER PLANT JOBS

Engineers and Scientists

(Generally requires a four-year Bachelor's degree and often requires postgraduate study)

- electrical engineers
- power engineers
- mechanical engineers
- design engineers
- environmental engineers
- nuclear engineers
- nuclear physicists
- environmental scientists
- civil engineers

Support Workers

(Generally requires at least a two-year Associate degree for technicians; technologists require a four-year Bachelor's degree)

- engineering technologists
- engineering technicians
- laboratory technicians
- environmental monitors

Blue Collar Workers

(Most jobs require apprenticeship. Some may require special nuclear certification)

- supervisors
- pipefitters
- electricians
- carpenters
- welders
- ironworkers
- boilermakers
- painters
- sheet metal workers
- bricklayers

Semiskilled Workers

(May require a high school education)

- truck drivers
- equipment operators
- laborers

Source: Compiled from *Opportunities in Energy Careers* by John Woodburn, National Textbook Company

Parameters and Problems

In order to meaningfully discuss career opportunities in energy-related industries, certain parameters are deemed necessary. This paper, as does ORAU, defines energy-related industries as those where jobs involve the production and distribution of energy resources. Specific industries included are: (1) coal, (2) oil and gas, (3) nuclear, (4) solar, (5) other energy sources such as wind, geothermal, biomass and (6) energy conservation. A portion of the construction industry is also included; namely, that part which requires special skills to work on energy facilities. Skills requirements and employment forecasts are unique to each specific industry. For this reason, each industry will be briefly presented. Since most counselors are involved in assisting the client in the first job, this paper concentrates on entry-level jobs in specific industries and on career orientation within energy-related industries in general. Counseling necessitates helping clients learn strategies for seeking jobs as well as finding opportunities for employment in specific fields. However, this paper necessarily limits the counseling function to that of gathering and conveying information about training and job opportunities.

Significant problems arise when energy-related information is presented. Current data may not be available. Inadequately defined categoreis for data presentation may cause confusion and misinterpretations. Inherent difficulties lie in making job needs assessment. For example, new jobs may be filled by both new entrants to the labor force and retrained workers. ORAU was once criticized for reporting in a 1975 study that there existed no immediate job market for *two-year* college graduates in solar technology. A solar industry spokesperson reproved the study and presented his projections of the number of solar installers currently needed to install solar collectors. The solar technicians required, however, were already employed craftsmen in the heating, ventilation, and air condition field who needed only *two weeks* of training to become adequate solar installers[16]

Predicting job demand has associated risks. Macrocosmic studies do not necessarily reflect conditions in specific locales. Data cannot be disaggregated easily to represent the local labor market. Authoritative, yet not always comprehensive and cooperative, involvement of federal agencies creates confusion. Also, private industries may overstate job needs to ensure an adequate labor force; whereas organized labor may resist labor force expansion so as to maximize benefits for present members.

New jobs often entail merely the retraining of existing employees. For example, the demand for conservation specialists has been forecast by many groups. Utility companies presently are retraining gas and electric appliance salespersons to make energy conservation audits of business and residences. These salespersons already possess the personal skills and the knowledge of energy necessary for the new jobs. They and the utility companies also have mutual commitments to one another.

A lack of parallelism in energy jobs across specific energy-related industries exists. Woodburn's job titles by industries listed in Table 2 present jobs in specific energy-related industries which in some cases appear similar. However, little similarity exists in job descriptions and working conditions between specific energy-related industries. For instance, the mine foreman in the coal industry has no counterpart in the nuclear industry. Research and development jobs in the oil and gas industry require entirely different skills and evidence different working conditions than research and development jobs in the biomass energy area. In the newer energy industries, in particular, equating energy job titles to existing professional and scientific education becomes problematic. Mechanical engineers, electrical engineers, and architects may become energy management experts or may retain their original job titles. Also, in these newer energy-related industries the credibility of job training programs has been seriously affected by intermittent lack of job placement of graduates within their field of study. When placed, their job titles may, or may not, reflect relatedness to previous training.

A brief overview of career possibilities in energy-related industries illustrates the complexities of grouping energy occupations. Table 3: Job Titles in Six Energy-Related Industries presents a compendium of job titles within each industry by training and experience necessary for job entry. Job training and career possibilities, along with labor force demand, in these six energy-related industries and in the energy-related construction industry follow.

Energy-Related Industries

COAL—Thousands of job openings will occur each year as experienced miners retire, die, or transfer to other fields of work.[17] The increase for miners will be for both eastern underground mine workers and western predominately stripmine employment.

Traditionally, the coal industry hires untrained workers and

TABLE 3: Job Titles in Six Energy-Related Industries

	COAL INDUSTRY	OIL AND GAS INDUSTRY
ADMINISTRATORS, ENGINEERS AND SCIENTISTS (Jobs require four-year Bachelor's degree and may require postgraduate study.)	Accountant Analytical chemist Attorney Chemical engineer Civil engineer Coal gasification engineer Environmental engineer Geologist Geophysicist Market researcher Mechanical engineer Mine safety inspector Mining engineer Research scientist Safety engineer	Accountant Attorney Chemical engineer Chemist Civil engineer Computer analyst Environmental engineer Geologist Geophysicist Mineralogist Paleontologist Petroleum engineer Petrologist Photogeologist Purchasing agent Stratigrapher Training specialist
SUPPORT WORKERS (Technologists require four year Bachelor's degree. Technicians require two-year Associate degree.)	Engineering technologist Engineering technician Face boss Laboratory technician Preparation plant central control operator Pre-shift examiner Surveyor	Computer programmer Drilling supervisor (tool pusher) Engineering technician Engineering technologist Laboratory technician Lease buyer Observer Prospecting computer Scout Surveyor Refining operator Rotary driller
BLUE COLLAR WORKERS (Employment requires on-the-job training or an apprenticeship after a highschool diploma or its equivalent.)	Auger operator Carpenter Cutting machine operator Dragging operator Drilling machine operator Electrician Fitter Loading machine operator Mine worker Rock dust machine operator Roof bolter Separation tender Shot firer Shuttle car operator Stopping builder Stripping operator Tractor operator Wash box attendant Welder	Acidizer Cementer Computer operator Dehydration plant operator Derrick oper. Drafter Driller Electrician Gager Gas-compressor operator Gas-plant operator Instrument repairer Ironworker Perforator operator Pipefitter Pumpers Rig builder Rotary rig engine operator Sample taker Sheetmetal worker Switcher Treater Welder Well puller
SEMISKILLED WORKERS (Employment may require a highschool diploma or its equivalent.)	Bookkeeper Clerk Guard Laborer Mechanic Miner's assistant Secretary Truck driver Typist	Bookkeeper Equipment operator Guard Keypunch operator Laborer (roughneck or roustabout) Maintenance worker Pumper helper Rig-builder helper Rotary drill helper Secretary Truck driver Typist

TABLE 3: (cont.).

NUCLEAR ENERGY	SOLAR ENERGY	ALTERNATIVE ENERGY[1]	[illegible][2]
Accountant Attorney Biological scientist Chemical engineer Civil engineer Computer analyst Electrical engineer Health physicist Mathematician Mechanical engineer Metallurgical engineer Nuclear engineer Nuclear physicist Public information officer Radiation chemist Radiological chemist Radiological physicist Research scientist Safety engineer Training specialist	Architect Civil engineer Design engineer Electrical engineer Environmental engineer Solar engineer	Biologist Biological scientist Chemical engineer Chemist Civil engineer Design engineer Electrical engineer Environmental engineer Geologist Geophysicist Mechanical engineer Physical scientist Physicist	Accountant Attorney Civil engineer Computer analyst Design engineer Electrical engineer Environmental engineer Environmental scientist Mechanical engineer Nuclear engineer Nuclear physicist Power engineer Public relations officer
Accelerator operator Chemical process operator Computer programmer Decontamination worker Electronic technician Hot-cell technician Instrument technician Nuclear reactor operator Nuclear technician Physical science technician Quality control technician Radiation monitor Radiographer Radioisotope-production operator Waste disposal worker Waste treatment operator	Architectural technician Engineering technician Engineering technologist	Architectural technician Engineering technician Engineering technologist	Auxiliary equipment operator Boiler operator Computer programmer Control room operator District representative Engineering technician Engineering technologist Environmental monitor Health and safety specialist Laboratory technician Load dispatcher Plant supervisor Power plant operator Substation operator Switchboard operator Turbine operator Watch engineer (Shift supervisor)
Boilermaker Carpenter Computer operator Drafter Electrician Instrument repairer Machinist Millwright Painter (Radioactive materials) Pipefitter Plumber Sheetmetal worker Steamfitter Welder	Electrician Ironworker Plumber Sheetmetal worker Solar installer Welder	Drafter Electrician Engineering helper Instrument repairer Ironworker Machinist Welder	Boilermaker Cable splicer Carpenter Computer operator Electrician Instrument repairer Ironworker Line installer Machinist Meter installer Meter repairer Meter reader Meter tester Pipefitter Sheetmetal worker Trouble shooter Welder
Bookkeeper Clerk Laborer Maintenance worker Messenger Plant protection worker Secretary Typist	Bookkeeper Clerk Equipment operator Laborer Secretary Typist	Clerk Equipment operator Laborer Secretary Typist	Clerk Equipment operator Ground helper Keypunch operator Laborer Plant protection worker Secretary Truck driver Typist

[1] Includes wind, geothermal, biomass, etc.

[2] Includes energy transmission and distribution.

Source: Compiled and combined from *Energy-Producing Industries*, *Guide to Jobs and Energy*, *Occupational Outlook Handbook*, and *Opportunities in Energy Careers*.

provides them with on-the-job training during probationary periods of early employment. Recently, mine technology graduates of local vocational-technical training programs have been well received for employment. Experience and formal skills training are required for certification of mechanics, electricians, foreman, and supervisory personnel. Vocational programs usually are designed to meet specific needs of local companies and to comply with current regulations.

Engineers are needed for maintaining older mines and for prospecting for new mines. Both scientists and engineers work together in research facilities to develop and produce new coal products, such as solvent refined coal. Although ORAU and other groups concentrate largely on labor force information and training for technical jobs, a wide range of administrative, professional, technical and clerical personnel work in the coal industry, as well as in other energy-related industries. Such specialists as accountants, attorneys, market researchers supply legal, economic, and technical information for making policy decisions. Clerical personnel assist in management and operations.

OIL AND GAS—Employment needs for the entire oil and natural gas industry are difficult to predict. Refining, transportation, distribution and other related activities will vary with total output. The Bureau of Labor Statistics projects the number of oil and gas extraction industry workers, however, to exceed 600,000 by 1985, an increase of 50 percent over the current labor force.[18] Exploratory and drilling operations are increasing as conditions become economically favorable for exploration activities.

Although some petroleum production and refining occurs in almost all areas of the country, most of the employment opportunities in the industry are limited to a few states; namely, California, Illinois, Louisiana, Ohio, Oklahoma, Texas, Alaska, Colorado, Kansas, New Mexico, and Wyoming. Many new jobs in the industry will be located in the Rocky Mountain states and at off-shore drilling sites. Workers will also be needed at overseas facilities owned and/or operated by U.S. oil companies.

Scientists comprise about 12 percent of the workers in petroleum refining. These include chemists, chemical engineers, mechanical engineers and environmental engineers. Skilled laboratory technicians and drafters are also required. As in other energy-related industries, administrative workers and clerical personnel are in demand. Managers, accountants, purchasing agents, lawyers, computer programmers, computer analysts, and personnel and training specialists constitute only a few of the administrative jobs available.[19]

In addition to college programs in petroleum and chemical engineering and 135 education institutions offering two-year associate degrees in chemical technology, fifteen vocational schools and community colleges have been identified with petroleum programs for training oil and gas industry workers. The most successful programs cooperate with one or more petroleum companies to provide the required skills.

NUCLEAR—The role of nuclear power in the energy future is uncertain, although the number of nuclear power plants is expected to be several times greater in 1985 than in 1976. Anticipated growth will require an increase in the number of workers in design, construction, operation, and maintenance of new plants. Approximately 30,000 technicians, including drafters, were identified in 1977 as being employed in the nuclear field.[20] The nuclear fuel energy segment includes the mining, milling and conversion of uranium, as well as the enrichment, fabrication, and use of uranium in power plants, and the disposal and reprocessing of waste products.

Few education institutions seem eager to risk high equipment costs, time delays, and uncertain placement possibilities to develop nuclear programs. Of the 18 identified nuclear training programs in technical schools and colleges in 1975, a growing number have recently ceased training because of recruiting difficulties and high operating costs.

Research and development in the nuclear energy industry will require increases in the number of scientists, engineers, and technicians to improve efficiency of nuclear generation of electricity, as well as to develop peaceful uses of radiation, nuclear explosives, and biomedical applications of nuclear science.[21]

SOLAR—As users of solar energy systems increase, new jobs will be created in the design, manufacture, installation and maintenance of all types of solar systems. Sales, which include installation of solar space and hot water heating are reported to have increased tenfold between 1975 and 1977.[22] Divergence among estimates of direct labor requirements for solar technologies can be explained by the early stage of development of the industry.[23]

Realizing the amount of solar energy available from a practically inexhaustible source, the general public is attracted to solar energy career opportunities. At present, persons interested in employment far outnumber the demand for solar technicians. In 1978, twelve programs were identified as training solar technicians in vocational schools and junior colleges. One year later, 91 schools in 31 states reported programs and/or vocational offerings.

Engineers, scientists and architects are required to plan, develop, construct and maintain new solar systems. Most will not have solar education degrees. Traditional education and training, with options in solar energy, at this time provide adequate training and experience. To provide necessary training and experience for future workers in the solar industry, union spokespersons prefer the development of union apprenticeship programs to upgrade existing craftsmen.

OTHER ENERGY SOURCES: WIND, GEOTHERMAL, AND BIOMASS—Geothermal and biomass enthusiasts quote studies to show that geothermal energy is economically feasible. Bioconversion techniques are especially conducive to low capital enterprises which can create many jobs. The American Gas Association asserts that from a social or political standpoint "it appears desirable that gas be generated on a local basis from such sources as urban refuse, industrial wastes, sewage sludge and miscellaneous wastes.[24]

Although little research and development in wind power has been done in the past 30 years, the Technology Development Corporation has calculated that wind generation of electricity is currently economically competitive with other systems on the seacoast of the northeastern states.[25]

Jobs in the wind, geothermal and biomass conversion energy industries may develop. They will be few in number, geographically located, and concentrated in small companies. However, those interested in these energy areas should be aware that the more immediate jobs will be in research and development. Technicians, craftsmen, and service personnel will come from traditional training disciplines and not from specialized ones.

ENERGY CONSERVATION—National policies to decrease the rate of growth for energy demand will create employment opportunities in residential conservation and in conservation in large public, commercial and industrial buildings. Even though educators have contacted private industry and public utilities to explore the need for energy conservation personnel and the types of training necessary for specific jobs, experience and training required for jobs in this field cannot be specified nor generalized.[26] Initial demand, however, will probably be to upgrade current employees. Nevertheless, training programs are available in vocational schools and junior colleges. Program titles include resource management, energy conservation and audit, energy management, and energy conservation technology. Persons interested in energy conservation should be reminded how they can put their interests to use in construction, in engineering and/or scientific endeavors, and in the research and development aspect of all, but especially the newer, energy-related industries.

CONSTRUCTION ACTIVITIES IN ENERGY-RELATED INDUSTRIES—Although not an energy source, construction activities in energy-related industries will provide a significant number of jobs in this decade. For this reason, labor force needs of the construction industry are cited as an ancillary industry. Labor force studies suggest a growth in energy construction employment from the 1975 level of 284,500 workers to 486,220 in 1985.[27]

Critical shortages may develop in some job areas: the most serious of which will be among electricians, pipefitters, boilermakers, welders, and carpenters. While representing only a portion of these skilled workers, the special skills requirements to meet the energy-related construction needs may seriously impede the flow of skilled craftsmen to large energy projects.[28]

New entrants to the labor force should consider jobs in energy-related industrial construction. However, one must realize that union apprenticeship programs will be the major supply source of skilled building trades craftsmen. Graduates of vocational school construction trades programs will indeed be a source of employment for non-union contractors.

Recommendations and Implications for Counselors

As indicated from these brief energy-source and energy-area synopses, all energy-related industries are subject to potential growth. Long-term studies reveal patterns of historical growth and predict future employment increases. Recent observations on the national level indicate specific labor force needs and increasing availability of job training.

Specific recommendations to counselors and implications for counseling have evolved from the information herein presented:

- When clients express an interest in "energy," counselors should discuss with them their interests and expectations in order to clarify job possibilities and to translate that "energy interest" into specific energy-related occupations.
- Students, as well as counselors, need current, relevant labor force and training information about energy-related jobs and careers in energy industries. Counselors should point out to college applicants that energy options now

exist within traditional college curricula. Also, most opportunities for energy research and development are available only at the graduate and postgraduate levels. Job openings do exist, however, that are not typically associated with energy but are necessarily required for operations and management in any industry.

- Students interested in a specific energy-related industry should be provided with materials which describe the career patterns available within that industry and which also provide information about similar jobs in other related industries. These materials should specify what mixture of experience and training is necessary for job advancement. Table 3: Job Titles in Six Energy-Related Industries offers a composite picture, using sources identified in this paper, of energy-related jobs by training and experience.
- Counselors necessarily must seek out available energy-related information; yet they must constantly assess the quality of such information. The form and content of career education materials differ significantly. Counselors should beware of flashy materials with little substantive information. Materials must be assessed by the counselor with both a keen eye on local needs and a thorough knowledge of national trends. Recommended informational sources have been suggested throughout this presentation and additional sources appear in the attached reference listings.

SUMMARY

Future energy development involves interrelationships between energy policy, economics, education and employment. Counseling for career opportunities in energy-related industries becomes an important process for meeting national energy needs and goals. Job opportunities exist for prospecting for energy resources, for developing new energy resources, for extracting natural resources, for researching methods of storing newer energy resources, for processing and/or refining raw materials, and for sales and distribution of energy. The energy industry provides jobs for people who wish to design, build, maintain and operate machines and facilities. In short, for persons interested in energy, with careful planning, a wide array of job and career opportunities lie ahead.

REFERENCES

1. Bolles, Richard Nelson, *What Color Is Your Parachute?* Ten Speed Press: Berkeley, California, 1979.
2. American Personnel and Guidance Association, *The School Counselor and Career Education.* To be published in February, 1980.
3. Energy Information Administration, *Energy Supply and Demand in the Mid-Term: 1985, 1990, and 1995.* U.S. Department of Energy: Washington, D.C., April, 1979.
4. U.S. Department of Energy, *National Energy Plan II.* U.S. Department of Energy: Washington, D.C., 1979.
5. Doggette, John R., *Energy-Related Technology Programs in Community and Junior Colleges: An Analysis of Existing and Planned Programs.* Energy Research and Development Administration and American Association of Community and Junior Colleges: Washington, D.C., 1976.
6. Crowell, Mayme R., *Energy-Related Activities in Two-Year Postsecondary Vocational-Technical Institutions: A Representative Sampling by State.* U.S. Department of Energy: Washington, D.C., November, 1978.
7. Crowell, Mayme R. and Doggette, John R., "Technicians: Where Do We Stand?" *VocEd* (January, 1979), pp. 31–34.
8. Doggette, John R. and Stevenson, Wayne, "Energy-Related Employment and Vocational Education during the 1980s." *Curriculum Development Needs for Vocational Education: New and Changing Occupations* by Mollie N. Orth and Jill F. Russell. National Center for Research in Vocational Education: Ohio State University, in press.
9. Baker, Joe G., *Determinants of Coal Mine Labor Productivity Changes: A Progress Report.* Oak Ridge Associated Universities: Oak Ridge, Tennessee, January, 1979.
10. Blair, Larry M. and Doggette, John R., "Education, Training, and Work Experience Among Nuclear Power Plant Workers." Paper presented at the International Atomic Energy Agency's International Symposium on Manpower Requirements and Development for Nuclear Power Programs in Saclay, France, April, 1979.
11. Blair, Larry M., Burnett, William, and Mason, Bert, *Solar Energy Employment: Information from Case Studies.* Oak Ridge Associated Universities: Oak Ridge, Tennessee, December, 1978.
12. Hamilton, Bette, E., *A Survey of Energy Programs in Two-Year Colleges and Technical Institutes.* American Association of Community and Junior Colleges: Washington, D.C., 1978.
13. Hull, Daniel M., *Energy-Related Training Activities: Assessment of Current Offerings throughout the Country.* Technical Education Research Center—Southwest: Waco, Texas, January, 1979.
14. Bureau of Labor Statistics, *Energy-Producing Industries.* U.S. Department of Labor: Washington, D.C., 1978.
15. Woodburn, John, *Opportunities in Energy Careers.* National Textbook Company: Skokie, Illinois, 1979.

16. U.S. Energy Research and Development Administration, *Energy Technology Training Conference Proceedings*. U.S. Energy Research and Development Administration: Washington, D.C., 1976.
17. Baker, Joe G., *Determinants of Coal Mine Labor Productivity Changes: A Progress Report*. Oak Ridge Associated Universities: Oak Ridge, Tennessee, January, 1979.
18. Bureau of Labor Statistics, *Occupational Outlook Handbook*. U.S. Government Printing Office: Washington, D.C., 1978, pp. 620–21.
19. Bureau of Labor Statistics, *Energy-Producing Industries. U.S. Department of Labor: Washington, D.C., 1978.*
20. *Ibid*.
21. Bureau of Labor Statistics, *Energy-Producing Industries*. U.S. Department of Labor: Washington, D.C., 1978.
22. Modesto, Maidique, "Solar America," *Energy Future*. Random House: New York, 1979.
23. Mason, Bert and Armington, Keith, "Direct Labor Requirements for Select Solar Energy Technologies: A Review and Synthesis." Working paper of Solar Energy Research Institute: Golden, Colorado, August, 1978.
24. Grossman, Richard and Daniker, Gail, *Guide to Jobs and Energy*. Environmentalists for Full Employment: Washington, D.C.,1977.
25. Woodburn, John, *Opportunities in Energy Careers*. National Textbook Company: Skokie, Illinois, 1979.
26. Gallagher, J. Michael and Brady, William J., "Availability of Engineering Personnel for U.S. Energy Development Programs." U.S. Energy Research and Development Administration: Washington, D.C., 1976.
27. Sathaye, Jayant and Ruderman, Henry, *An Assessment of National Consequences of Increased Coal Utilizations*. U.S. Department of Energy: Washington, D.C., February, 1979.
28. Gallagher, J. Michael and Teather, Jeff S., "Availability of Manpower for U.S. Energy Development Programs." U.S. Energy Research and Development Administration: Washington, D.C., 1976.

The Development and Dissemination of Career Information for Students/Workers

Russell B. Flanders, Executive Director,
National Occupational Coordinating Committee,
Washington, D.C.

INTRODUCTION

This paper outlines the activities of the National Occupational Information Coordinating Committee and its 57 counterparts—the State Committees. In addition to introducing a new set of acronyms to the language of government—such as NOICC, SOICC's, OIS, and CIDS—the committees have made some significant accomplishments toward fulfilling their legislative mandates.

For those of you who are not familiar with the NOICC mandates, I will review them briefly. The Education Amendments of 1976 call for NOICC to:

(1) Improve coordination between, and communication among, vocational education and employment and training program administrators and planners, research personnel and others; and: (2) develop and implement an occupational information system to meet the common occupational information and data needs of vocational education and employment and training programs. Importantly, this system ". . . shall include data on occupational demand and supply based on uniform definitions, standardized estimating procedures, and standardized occupational classifications." This legislation also calls for NOICC to assist each State Occupational Information Coordinating Committee, or SOICC, including assistance in the implementation of the Occupational Information System, or OIS.

The Comprehensive Employment and Training Act (CETA) Amendments of 1978 call for NOICC and the SOICC's to give "special attention to the labor market information needs of youth." The law lists six areas of activity under this broad mandate. Examples include "assisting and encouraging the development of State occupational information systems, accessible to local schools;" "providing technical assistance for programs of computer on-line terminals and other facilities to utilize and implement occupational and career outlook information and projections supplied by State employment service agencies . . . ;" and "encouraging programs to make available employment and career counseling to postsecondary youths."

Elsewhere in the CETA legislation, the Governors are called upon to foster the activities of the SOICC's "with special emphasis on the systematic use of occupational information for prime sponsor planning, as well as assisting and encouraging the development and use of career outlook information for individuals. . . ."

This overview of legislative mandates, I believe, clearly shows that NOICC and the SOICC's are very much involved in the development and dissemination of career information.

It has been stated, on occasion, that NOICC is a part of the U.S. Department of Labor or the U.S. Department of Health, Education and Welfare. In fact, NOICC is a part of both Departments. As specified in the enabling legislation, NOICC consists of the Commissioner of Education, the Administrator of the National Center for Education Statistics, the Assistant Secretary for Employment and Training, and the Commissioner of Labor Statistics. These statutory members are jointly responsible for the operation of NOICC. Likewse, the statutory members of the SOICC's are jointly responsible for their operation. The State agencies included in each SOICC by law are: (1) the State board administering vocational education, (2) the State Employment Security Agency, (3) the State Employment and Training Council, and (4) the State agency administering the vocational rehabilitation program.

I provide this detail to show that NOICC and SOICC are in fact coordinating organizations with their staffs (including me) operating under the guidance and supervision of statutory members of each committee. We are facilitators, and any programmatic functions performed are authorized by the statutory members. Furthermore, published policy states that "NOICC will not be a primary data collection agency but shall coordinate such efforts principally among its member agencies."

Accomplishments

Working within this setting, several NOICC/SOICC accomplishments are:

- Several basic policy determinations have been made to delineate the parameters of the Occupational Information System (OIS). Significantly, the Occupational Employment

Statistics (OES) program of the U.S. Department of Labor is the "principal source of current and projected occupational data" used in the OIS. Occupational supply data will be used in the OIS from several established programs or data systems, including data collected through the Unemployment Insurance Service System, the Employment Security Automated Reporting System, the Higher Education General Information Survey, and the Vocational Education Data System, among others. To avoid duplication of effort, NOICC and the SOICC's will integrate data from these systems into the OIS.

- "A Framework For Developing an Occupational Information System" has been published that includes sections on the concept and structure of the OIS, the delivery of occupational information, and the SOICC's operational alternatives for implementing an OIS, as well as technical appendices. Interestingly, this publication represents a multi-agency effort. It sets forth for the first time the content of an occupational information system, a system designed to serve the two major purposes of providing the information needed by education and training program administrators and planners and, to the maximum extent possible, the information needed in career information delivery systems.
- A publication called "NOICC-Related Activities: A Review of Federal Programs" has been published. This publication identifies more than 160 Federal programs involved in the production and/or use of occupational and related educational information. A description of each program is presented, along with program location by agency, the authorizing legislation, major publications, mailing address, and a contact person. Although originally developed by NOICC to identify the scope of possible coordination and communication activities, the report serves another important purpose. The Office of Career Education and NOICC are cooperating on its distribution to ". . . furnish information to interested parties on Federal programs which gather, analyze, and disseminate occupational and career information." This joint action is pursuant to the requirements of the Career Education Incentive Act of 1977.
- NOICC has provided several grants to SOICC's for research and development projects concerned with the development and implementation of the OIS. Projects are being conducted in several States to test methods proposed

by the Bureau of Labor Statistics for estimating occupational employment in sub-State areas. A project to develop a methodology for estimating labor supply originating from CETA training is in process and other efforts are under way to estimate occupational employment in agriculture.

In addition to these research projects, SOICC's are conducting workshops to determine the needs of all the users of occupational information in the States. They also are involved in activities to enhance the development and delivery of occupational demand and supply information to planners of vocational education and CETA training programs. At least 10 SOICC's are involved in cooperative State-agency efforts to fund the OES program when funds provided by the U.S. Department of Labor for this program are insufficient or, in the case of the OES survey, nonexistent. The Alabama SOICC, for example, has published supply/demand interface information for the State and for eight major planning districts in the State. Comparable efforts are under way in other States, all of which involve cooperation among and resources provided by members of the statutory agencies.

Career Information

With regard to career information, NOICC and the SOICC's are involved in another group of projects. The Florida SOICC, for example, is designing, developing and pilot testing a standardized measurement system to assist handicapped persons in the use of career choice programs and career information. Among other projects, the Wisconsin SOICC is developing a mechanism to access occupational information stored in the computerized systems in the nine States funded by the Labor Department's career information systems grants program. A model being developed involves Wisconsin and Minnesota.

Last fall, NOICC announced awards to 15 SOICC's "to encourage and aid in the development and implementation of Statewide Career Information Deliverv Systems, called CIDS. The CIDS program concept is based on the U.S. Department of Labor's earlier demonstration program. In the proposals submitted to NOICC, the SOICC's were required to be concerned with the use of existing data sources rather than with basic data collection, insofar as possible. (In fact, NOICC's policy notice states that the information used in these systems should be obtained from the Occupational Information System to the maximum possible extent.) In addition, the system should use the

Standard Occupational Classification as the primary classification system within which occupational titles and descriptions will be presented.

Broadly stated, the information components to be included in the delivery systems are:

1. *Descriptive Information About Occupations*, e.g., job duties, working conditions, related jobs, and opportunities for advancement.
2. *Requirements of the Occupation*, including personal requirements and constraints to job entry such as licensing and work experience.
3. *Economic Information About Occupations*, including outlook and earnings information.
4. *Education and Training Information*, including sources of training, school programs, and financial assistance.

In addition, these delivery systems are to include appropriate national, State and local information.

Although stated in general terms, you will note a similarity between these requirements and the standards published by the National Vocational Guidance Association. Indeed you should, because NOICC's requirements are based on NVGA standards.

The 15 States funded by NOICC, added to the 9 States funded by the U.S. Department of Labor, bring the total to 24 States that have or soon will have operational Statewide career information delivery systems. Great interest on the part of other States to develop systems has been expressed to us over the last few months. NOICC has heard from 17 States suggesting their interest, and a few have begun to study the feasibility of initiating systems without funding support from NOICC as a part of the grants program. The point here is that, increasingly, career information delivery systems are becoming an important method for providing career information directly to youth and to counselors and other intermediaries who assist youth in the career decision process.

I have made several references to the development by NOICC of an Occupational Information System. I have referred to the authorizing legislation, which calls for standardization of classifications and procedures. I also have mentioned that the Occupational Information System is to be the basic source of information for Career Information Delivery Systems funded by NOICC. Fully implemented, such a system will make possible greatly improved and more accessible occupation information, including information about energy-related employment opportunities.

The Occupation Information System being developed by NOICC adopts standardized procedures that provide for compatibility of occupational information among localities and States, in terms of concept and content. They call for the development of occupational employment patterns by industry, which makes possible the analysis of the number and types of workers associated with energy, such as petroleum, coal mining and power generation. Furthermore, they provide a basis for identifying the number of workers in specific occupations, trends in employment, and a basis for analyzing occupational supply. As energy-related employment increases in importance and as new occupational specialities are identified in this and other fields, these capabilities will become more important.

Changes in Job Content

There are problems in the development and dissemination of career information related to energy that should be recognized. Although it is relatively easy to identify the types and number of workers employed in the traditional energy industries, such as electrical power generation, it is much more difficult to identify within certain industries and occupations the changes in job content that have occurred recently because of new energy-related technology. This situation has an obvious bearing on training requirements and curricula.

While organizations have reported on the identification of new occupational specialties, past experience suggests, however, that not all employers have adopted new job titles. Many employers are assigning different tasks to workers without a change in job titles. Employers also may be providing the required special training needed by the workers. Such circumstances make it difficult to provide to young people complete and timely information on opportunities and requirements in the energy field. To address these types of problems and to make possible the delivery of reliable information to youth about energy-related careers will require, I believe, the cooperation of several agencies and organizations.

There is a need for this type of network. The information developed on energy-related careers should be made available via several media, including the Statewide Career Information Delivery Systems supported by NOICC. The development and delivery of new career information should be done in a coordinated, systematic manner. The information gathered in this work should form a solid basis for an interagency effort to bring to the attention of youth the opportunities in the energy field and to meet the accompanying training needs.

Orienting America's Youth Towards Future Energy Careers

Ann L. Borden, Executive Vice President, National Energy Foundation, New York, N.Y.

In its first six years of operations, SEER—the Student Exposition on Energy Resources—has stimulated the creative imaginations and motivated the active participation of no fewer than twelve to fifteen thousand secondary school students in the five boroughs of New York City alone.

Within the most recent twelve months, it has expanded to involve additional thousands of junior and senior highschoolers in several communities in New Jersey, in Los Angeles, Fairfax County, Va., and two areas of Connecticut, as well. Its future further broadening is indicated by the constant expressions of interest originating with educational authorities in other communities throughout the United States, which arrive virtually daily in the headquarters offices of SEER's sponsor, the National Energy Foundation.

SEER has caught on because it meets a fundamental need within the nation's school systems: it provides a pragmatic educational base for evoking a classroom response to the cause to which corporate-supported, non-profit NEF is dedicated—"developing an awareness among America's school population of the energy-related changes—scientific, economic, social and political—that will affect their future."

SEER is the flagship project in an all-inclusive series of NEF programs, all distinctly related to promoting a consciousness of the vital need for energy education activities in the schools, and including educator workshops, a student essay contest, the establishment of a library and Energy Resource Center with books and other printed and visual materials available to educators and students alike, grants to encourage the development of energy-related curricula, and an annual convocation, at which prominent personalities in the world of science lecture to and chat with secondary school students.

What is the methodology employed by SEER? And what is the effect of this program on the educational progress of the students—and the educators—exposed to it?

The concept underlying SEER is a simple one. Each year, many months in advance of the late May public exposition which is its annual culmination, NEF uses literature and meetings as a means of involving superintendants, supervisors, principals and teachers in the process of encouraging their science and social science students to conceive and actually construct working models, dioramas and mock-ups of methods and devices aimed primarily at solving the nation's energy problems. Within each school, entries are screened and a choice few are selected for ultimate public display.

In the New York area alone, this process has each year resulted in the exhibit of an average of about two hundred and fifty mature and highly sophisticated approaches to the overall problem; in addition to the thousands of young people who participate and who involve their teachers, parents, families and neighbors, the public exposition has drawn an average attendance of some fifteen thousand or more members of the general public.

Among the advanced concepts exhibited by students ranging from thirteen to seventeen years of age have been these:

- A Biosphere Independent of Energy Supplies
- Hydrogen as an Alternative Fuel Source
- Electrostatic Direct Energy Conversion in Mirror Fusion Reactors
- Utilizing the Heat Generated by the Composting Process
- Electrical Energy Produced by a Methyl Formate-Air Fuel Cell Using Glauber Salts to Store Solar Energy
- A Solar-Powered Pace Maker

At the annual public SEER exposition, which runs for about ten days in some conveniently located civic building, a panel of judges representing technicians and scientists, educators and administrators, and civic authorities selects about a dozen entries from among the several hundred on display for top honors. Winning youngsters receive a variety of awards, including cash prizes, certificates and—not the least in the scale of satisfaction—coverage by the print and broadcast media.

That is SEER . . . but what has it meant to the student participants themselves, to the educational community and to the business world?

Exposure to the concept of SEER and actual participation in the program has had a marked effect upon countless numbers of students. It has opened, to some, vistas of new career directions which, prior to SEER, had not even occurred to them. For others, whose exhibits have aroused the admiration—and even the astonishment!—of professional scientists and technicians representing many of the nation's major corporations, it has meant a continuation of their educational advancement (which they and their families might otherwise not have been capable of financing) through scholarship awards. In at least one case, a student concept embodied in a device he created and exhibited in an earlier year resulted in an application for a U.S. Patent on a new mining process, submitted in the student's name by a leading company.

One typical example of how NEF and SEER have exerted major influence on the direction of a student's projections of where his life should take him can be found in the case of a young Brooklyn schoolboy, Nevin Cohen. A junior high school pupil when the first Student Exposition on Energy Resources was announced back in 1975, Nevin became a SEER enthusiast. During each of his two final years at junior high school and throughout his three-year attendance at John Dewey High School, he entered projects, emerging as one of the top winners on four of those five occasions.

Noting that "I have grown up with SEER," Nevin says, "I recognize now that the very first SEER opened the doors to an area of study, and to the possibilities of a lifelong career, in a field I had previously all but ignored."

Now a student at Cornell University, where he is majoring in government and economics, "with a strong concentration in natural resources and geology courses," he recalls his continued involvement with NEF and its programs:

"Not only did SEER make me explore scientific and social science topics, but it encouraged me to speak out and to be concerned about all aspects of the energy picture.

"Each successive year provided me not only with a medium for exploring science, but with an opportunity to broaden and develop my own knowledge and techniques. I designed projects involving such concepts as fuel conservation, passive solar design, magnetohydrodynamics, and even a novel and untried idea: composting for heat generation. I participated in other NEF programs and projects, too; convocations, lectures and discussions all helped to enrich my educational experience.

"As evidence of SEER's impact on my life," he summarizes, "I am now entering college in pursuit of an education that will enable me to find a lifetime career in the energy field. From my first project in the seventh grade right up to my college entrance, *NEF has guided and shaped my interests and concerns.*"

Nevin Cohen's experiences are not unique among the many dozens of young people who have been adjudged top SEER winners over the years for the unusual quality of their exhibits.

But how has the reality of SEER affected the many thousands who work each year at creating exhibits that do not make the final public exposition, that do not get past the school or perhaps the district level? What has been the impact of this program on their teachers, principals and supervisors?

School District 6, in New York's borough of Manhattan, provides some answers. Each year, some weeks in advance of the announced SEER opening date, District 6 stages its very own miniSEER at which those student-created concepts which have been selected from the many submitted within each of the district's schools are judged and evaluated, with the winners forwarded for entry in the later citywide exposition.

Set up in the lobby of a local bank, and enthusiastically supported by neighborhood business organizations, District 6's miniSEER arouses interest and excitement among the several hundred thousand people who live in the area who have come to see not only their children's exhibits, but also to meet such distinguished judges as NASA's Major Frederick D. Gregory, the nation's first black astronaut, and Dr. Rhea Seddon, a NASA female astronaut.

"The resounding success of our fair," says Dr. James Roberts, deputy superintendent of District 6, "produced an unusual number of entries in the Student Exposition on Energy Resources . . . An astounding number of first-place honors afforded our children the opportunity to visit a number of interesting places, including far-off Israel.

"The effect of this type of recognition," he notes, "has been profound, and has evoked great improvement in student attitudes."

The "interesting places" Dr. Roberts refers to are the destinations of special tours and trips awarded by major private sector corporations in conjunction with an important educational facet of the SEER program—the NEF Corporate Awards Program.

Every year since the beginnings of SEER, executives and technician experts representing an ever-increasing number of industrial firms have visited the SEER exhibit, carefully examining the many entries, talking with and questioning their young creators. Selecting those entrants whose efforts are distinctly related to the specific areas of interest which concern the individual corporations, they select anywhere from two or three to thirty or more youngsters for special trips to and tours of energy-related installations throughout the U.S. and in some foreign nations, as well.

Moving far beyond the confines of the classroom, these successful entrants have extended their educational development by visiting an offshore rig in the Gulf of Mexico, an energy-producing garbage reduction installation in Milwaukee, a solar energy plant in Israel, a paper mill in Canada, recycling operations in Virginia, a coal gasification site in Illinois, as well as through luncheon and dinner meetings with top echelon industrial executives.

Such trips, entirely underwritten by each sponsoring donor, enable students to see firsthand the many things being done to ensure energy resources for the future, and to share ideas and experiences with professionals doing research similar to their own. Students meet with corporate executives, top scientists and technicians, to learn directly the complex and fascinating processes of business and industry, relating not only to energy production and use, but also to the wider spectrum of the mechanics of American business.

The impact on each of the many hundreds of students who have been rewarded with these trips over the past several years has been profound. Here is what some of them have to say:

Of a four-day trip to the Florida Institute of Technology at Melbourne, Fla.: "The places which we visited could not have been better picked from a standpoint of pleasure and learning. Because of this trip, I have gained further insight into the various energy fields. I gained a good understanding of F.I.T. and have bettered my career."

Of a tour of RefCOM's methane gas facility at Pompano Beach, Fla.: "We were permitted to speak to the chemists and engineers, and also to observe the intricate parts of the only plant of its kind in the country. This trip was undoubtedly the high point of my summer, combining science and fun in a wonderful balance."

Of a series of inspections of International Paper Company installations in three states: "We were all afforded an enriching experience which enabled us to understand the relationship between industry, energy and the environment."

Of a tour of International Nickel Company's reclamation plant in Ellwood City, Pa: "My trip gave me quite an increased understanding of technical considerations involving not only of a mill, but of an industrial plant. As it turned out, quite to my benefit, the trip dealt with an overall aspect of my project, and not just a small area."

Comments akin to these have resulted from virtually every Corporate Awards Program trip undertaken by student winners over the course of the SEER operation, whether the sponsor has been one or another of the nation's major corporations. Transporting students to the inspection site by bus, airplane, helicopter or even, as on one occasion, by company-owned executive yacht, the cooperating business organizations have included, among many others, such firms as Texaco Inc., American Can Company, American Express Company, Brooklyn Union Gas Company, Ingersoll-Rand Company, Transco, Union Pacific Corporation, United Technologies Corporation, American Telephone & Telegraph Company, Allied Chemical Corporation, Exxon, Public Service Electric & Gas Company (New Jersey), The New York Daily News, R. J. Reynolds Industries, Inc. and Garden State Paper Company.

The many business organizations cooperating with NEF through their participation in the Corporate Awards Program have benefitted to an extent paralleling the students' gains. They have made it possible for young people to meet face to face with corporate executives, managers and workers on all levels and thus to provide the students with some understanding of the real role of the business world in the nation's economic and cultural life. They have been enabled to demonstrate to the consumer public, through their internal and external community relations outlets, their sincere concern with the energy situation and their understanding of the need to educate tomorrow's producers and consumers, leaders and voters, executives and employees to a similar level of awareness. They have discovered for themselves the true extent of young America's deep involvement with energy-related problems and the mature and sophisticated manner in which students are approaching the energy crisis.

But, of at least equal importance to its impact upon students and the business world is the effect NEF has exerted upon the educational community—the supervisors, principals and teachers whose responsibility it is to supervise and guide the training of America's young people, and to prepare them to assume the future mantle of active citizenship.

Through workshops, convocations, surveys, grants and a host of other related activities, the National Energy Foundation has stimulated a nucleus of educators to begin to think about the role of the school in the development of "energy education" as a vital component of the curriculum in the secondary schools of the United States.

Working, for example, with a modest grant furnished to him by NEF, a teacher at New York City's Stephen A. Halsey JHS, Philip Solomon, has been stimulated to devote months of research into the development of a ninth grade "energy module" which has been introduced as a six-week mini-unit within one of his school's regular science courses.

Noting in his original prospectus that "we are being bombarded around the clock with false or misleading scare stories," he pointed out that "all this rhetoric can be confusing to the average consumer and more incomprehensible to today's teenager. Today's junior and senior high school students will have to deal practically with these considerations in their adult lives. It is for this reason that a comprehensive course of study be developed to inform students as to what the 'energy crisis' really is."

The mini-unit is currently being tested under NEF sponsorship and, after review and evaluation, will be made available as an educational aid to secondary schools throughout the U.S.

The National Energy Foundation has also prepared, published and distributed throughout the educational community the first issue of its "Energy Guide," a periodical aimed at serving as a directional pointer for teachers interested in showing their students the depth of interrelationship that exists among the many areas of human activity that are affected by energy problems. Two suggested introductory lessons—one for science classes, the other for social science classes—were provided as part of the initial issue. Educators have responded by suggesting topics to be discussed in future issues, ranging from breeder reactor waste disposal and electric-hydrogen automobiles to suggestions for class projects and home conservation techniques and procedures.

In both New York and Los Angeles, the Foundation regularly conducts educator workshops, attracting a total of about 500 concerned teachers in an average year. Science, mathematics and home economics teachers have been in the majority of those participating, and program emphasis has been on the desirability of teaching energy-related subjects in an interdisciplinary format. Curricula and methodology are discussed, supportive printed materials—garnered by NEF from many sources—are either distributed or their availability is made known, pertinent films are shown, and the impact of SEER participation upon both teacher and student is discussed.

The future lifestyle of today's student will be materially affected by developments in the areas of energy sources, energy supply, energy usage and energy conservation.

Tomorrow's citizen will live in the kind of home that is designed to adapt to developments in energy-related areas; the cultural pursuits, economic practices, social activities and political attitudes of tomorrow's Americans will all be forged and shaped by the type, amount and cost of energy units available to this nation in the years ahead. The National Energy Foundation devotes its own energies toward helping today's youth—through today's school systems—prepare to cope with the vast changes that lie ahead, by helping young people understand why such changes are necessary and by giving them an opportunity to develop their own individual talents in search of solutions in both science and social science.

Through its SEER program, and with its related energy education projects and activities, NEF has already had important impact on educators, students and the business community toward this end.

Career Education and the Energy Crisis

Kenneth B. Hoyt, Director, Office of Career Education, United States Office of Education, Washington, D.C.

INTRODUCTION

On November 8, 1978, the *Washington Star* published two articles, side by side, that attracted my attention. One, by Sylvia Porter, was entitled "Increasing Productivity: A Solution To Inflation" and quoted the following statistics relative to rises in productivity during the 1962–1977 period:

Japan—8.4% per year
Netherlands—6.9% per year
Belgium—6.9% per year
France—5.7% per year
Germany—5.5% per year
U.S.A.—2.7% per year

The second article, by Rudolph A. Pyatt, Jr. was entitled "Report on Jobless Youth Sees Need For Coordinated Efforts". In calling for better cooperation among community elements concerned with the problem, Pyatt noted that, despite 500 separate programs and "untold millions of dollars" being spent, unemployment in the District of Columbia is 25.3% for minority males and 23.1% for minority females. The study Pyatt reported cited four basic reasons for these statistics including:

—Lack of basic skills
—Dependence on welfare
—Despair or lack of hope for the future
—Peer pressure not to work

My purpose is to show that statistics, such as these, deserve some consideration in a work devoted to the general topic of "Education And The Energy Crisis". To do so, these remarks are divided into three parts: (a) the problem; (b) a set of suggested solutions; and (c) a set of challenges for those in the energy field.

The Problem—America's Energy Crisis: Part II

America's human energy crisis is just as real and just as crucial as is our physical energy crisis. We are importing too much productivity just as we are importing too much foreign oil. We are using our human energy inefficiently just as we are making poor use of our physical energy. We have failed to develop our human energy resources to their highest potential just as we have failed to develop our physical energy resources to their highest potential. The wise and prudent use of physical energy is now recognized as a needed priority for America. It is my contention that productivity must also become a priority for America. It is my further contention that these priorities are directly and intimately related in several important ways.

The Education system in the U.S.A. faces important responsibilities with respect to both of these priorities. The majority of this Conference has been properly devoted to consideration of how American Education can best meet its responsibilities with respect to the physical energy crisis. I want to comment here on how American Education can best meet its responsibilities with respect to America's human energy crisis. If productivity is to become a priority for America, it must surely begin with educational productivity. No long run societal problem can be truly solved unless we are willing to start with the youth of our Nation.

First, let us look at the problem of providing youth with basic academic skills. The problem is *not* that youth do not desire such skills nor that their teachers don't want to provide them. A new generation of youth enter our Kindergartens each Fall eager to learn. Their parents are even more eager. Yet, before reaching the fourth grade, many such youth are demonstrating a disinterest in learning the basic skills. Much research exists—in areas such as individualizing instruction and mastery learning—demonstrating how to increase the learning of basic skills. The reasons why such approaches aren't being widely used are varied and complex. One such reason has been our failure to show both pupils and their teachers the importance and utility of the basic skills in the occupational society—i.e., providing the teacher with an "up front" reason for teaching and the pupils an "up front" reason for learning.

Second, consider the reported problems of "dependence on welfare" and "peer pressure not to work". I, for one, simply do not believe that today's youth don't want to work—there is too much evidence to the contrary. Rather, there are two other basic problems that must be faced here. One such problem is that of recognizing the absolute necessity of helping youth view work, in today's society, as an alternative lifestyle available to them—i.e., of helping them acquire a personally meaningful set of work values as part of their total system of personal values. "Work" is regarded by too many youth today as a dirty four letter word. To the extent that is true, the fault is ours. Blame should not be placed on youth.

The other—and related—problem is that youth do not understand enough about work in America—about the American system of private enterprise. Nobody talked about "excess profits" when hula hoops were a raging success in this country. If our youth need to understand "work" as a good four letter word, they also need to understand both "profit" and "unions" as good six letter words. They certainly need to understand that, as profit comes to American companies, strength comes to America. They also need to understand that the future strength of America depends on their views of work and how they will fit into our occupational society.

Third, consider the finding that youth demonstrate "despair or lack of hope for the future". Again, two basic problems must be recognized. The first is that most youth in our K-12 system of education are career undecided — they have not made specific, final career decisions. Further, this condition is normal—not abnormal. It is what is expected based on what is known about the process of career development.[1,5,7] The age of adolescence is, for most youth, an age of tentative—not final—career decisions. The other basic problem here is the rapidity of change in our occupational society. The prime certainty facing most youth today is the certainty of uncertainty—the certainty of rapid change. Our current physical energy crisis will obviously greatly increase both the magnitude and the severity of this problem.

Career Education: One Solution To The Problem

Many "solutions" to America's energy crisis are needed and being generated. I propose "career education" as one kind of solution that deserves consideration because it relates directly to both America's physical energy crisis and its human energy crisis.[10] Three basic elements are involved in the "career education solution".

First, career education advocates propose creating a series of "partnerships" between the education system and the broader community aimed at helping youth better understand and deal with education/work relationship problems. These problems can never be solved solely by the education system itself. Education possesses neither the knowledge, the facilities, nor the expertise required. A joint undertaking involving joint authority, responsibility, and accountability between the education system and the broader community must be undertaken. The procedures for doing so have been developed.[11,12] Further, clear evidence exists that these procedures are working.[13]

Second, career education advocates propose an emphasis on equipping all youth with the kinds of general employability/adaptability/promotability skills that will enable them to change with change in our rapidly changing occupational society. Examples of such skills include: (a) good work habits; (b) work values leading to a desire to work; (c) skills in understanding and appreciating the private enterprise system; (d) skills in career decision-making; (e) skills in self-understanding and understanding of educational/occupational opportunities; and (f) job seeking/finding/getting/holding skills. Such skills will be valued by employers and valuable to youth no matter how rapidly change comes to our occupational society. Career education has demonstrated its ability to deliver such skills.[4,8,9,14]

Third, career education proposes changing the American education system in ways that allow these general promotability/adaptability/promotability skills to be delivered to youth in a longitudinal, developmental fashion through infusion into regular classes throughout the entire Education system. To do this requires the kinds of "partnerships" described earlier. The basic proposal is to use such "partnerships" in infusing these skills into the regular curriculum in ways that allow them to serve as a motivational vehicle for learning the basic academic skills included in the curriculum. The viability of this element of career education has also been demonstrated.[3]

The Challenge To The Physical Energy Field

America's physical energy crisis and America's human energy crisis are obviously very closely related. Our physical energy crisis has obviously been a great contributor to America's economic problems—including both inflation and problems related to employment and unemployment. Even more obvious are the many ways in which America's physical energy crisis will contribute, in the next several years, to rapidity of change in our occupational society. Such changes will be relatively minor if only new occupations in the physical energy field are considered. They will be even greater in terms of changes they bring to almost every other major part of America's occupational society. The physical energy crisis today stands as a major part of the problem of America's human energy crisis. If we can agree it is part of the *problem*, then I would hope we could also agree it should now move toward becoming part of the *solution*. Career education offers three challenges to the physical energy field for doing so.

First, we challenge major corporations in the physical energy field to join in the many career education "partnerships" being created with the education system. Many large corporations—

including, for example, General Motors, General Electric, AT&T, American Cyanamid, and McDonalds Corporation—have already done so. So, too, have major elements of organized labor and many smaller independent businesses. To date, I know of no major oil company, no major coal company, or no major producer of solar energy that has made a similar kind of commitment. True, at the local community level, there are some notable exceptions, but I am speaking here about national corporate commitments. Why have such commitments not been made? What can be done to secure them?

Second, we challenge major corporations in the physical energy field to join career education advocates in supporting the need for and participating in the delivery of general employability/adaptability/promotability skills to our Nation's youth. Many such corporations have supported efforts aimed at improving the quality of working life for adults. The close relationships between the "quality of working life" effort and the "career education" effort have been made abundantly clear—most recently by Bernstein.[5] They have not yet been capitalized on by major corporations in the physical energy field.

Third, we challenge those concerned with educating our Nation's youth regarding physical energy problems and concerns to join as a "partner" in career education's delivery system in the classroom. Certainly, the knowledge and attitudes that need to be conveyed must be delivered in a longitudinal, developmental fashion beginning in the early elementary school years and continuing throughout the education system. Career education offers a strategy for doing so. Certainly, those who wish to insert an "energy emphasis" into American Education can gain greater acceptance from educators if they use the "threading in" strategies of career education. Teachers will accept some new content being "threaded into" what they teach, but they will resist if such content is suggested as something to be "added on" or "taken away" from the regular instructional content itself. Finally, career education offers a strategy with a solid "what's in it for me?" basis for both teachers and students. Such a strategy appears to be very much needed by those now concerned with inserting an "energy education" emphasis into American Education. In short, career education offers a set of strategies, not only for beginning a new effort, but also for sustaining it. That career education's strategies work is well illustrated by Brodinsky who, after observing that the average life of an educational ref[illegible] movement in the U.S. is about three years, pointed out th[illegible] career education is still "alive and well" after a full decade o[illegible]stence.[6]

Concluding Remarks

I am well aware of the fact that those charged with prime responsibility for solving America's physical energy problems have "more than they can say Grace over" at the present time. In spite of this, I hope some will find it possible to consider and act constructively upon America's "energy crisis No. 2". These two crises *are* related and need to be attacked simultaneously.

REFERENCES

1. Ansell, E. M. & J. C. Hansen "Patterns In Vocational Development Of Urban Youth" *J. Counseling Psychology*, 1971, *11*, 505–508.
2. Bernstein, Paul *Career Education And The Quality Of Working Life*. Washington, D.C.: U.S. Government Printing Office, 1980.
3. Bhaerman, Robert *Career Education And Basic Academic Achievement: A Descriptive Analysis Of The Results*. Washington, D.C.: U.S. Government Printing Office, 1977.
4. Bonnet, Deborah G. *A Synthesis of Results and Programmatic Recommendations Emerging From Career Education Evaluations In 1975–76*. Washington, D.C. U.S. Government Printing Office, 1978.
5. Borow, Henry "Research In Vocational Development: Implications For The Vocational Aspects of Counselor Education" (in) *Vocational Aspects of Counselor Education* (Carl McDaniels, Editor). Washington, D.C.: The George Washington University, 1966.
6. Brodinsky, Ben "Something Happened: Education In The Seventies" *Phi Delta Kappan*, 1979, *61*, 238–241.
7. Coleman, J. S. *Youth: Transition To Adulthood*. Chicago: University of Chicago Press, 1974.
8. Datta, Lois-ellin et al. *Career Education: What Proof Do We Have That It Works?* Washington, D.C.: U.S. Government Printing Office, 1977.
9. Enderlein, Thomas *A Review of Career Education Evaluation Studies*. Washington, D.C.: U.S. Government Printing Office, 1976.
10. Hoyt, K. B. *A Primer For Career Education*. Washington, D.C.: U.S. Government Printing Office, 1977.
11. Hoyt, K. B. *The Concept of Collaboration In Career Education*. Washington, D.C.: U.S. Government Printing Office, 1978(a).
12. Hoyt, K. B. *Refining The Concept of Collaboration In Career Education*. Washington, D.C.: U.S. Government Printing Office, 1978(b).
13. Hoyt, K. B. "Career Education: A Report Card For The 70s And Some Predictions For The Decade Of The 1980s".Washington, D.C.: Office of Career Education, USOE, 1980.
14. Office of Career Education, USOE *Career Education Programs That Work*. Washington, D.C.: U.S. Government Printing Office, 1979.

Opportunities for Women in Energy

Mary Lou Randour, National Institute of Education, Washington, DC

INTRODUCTION

That there was a topic at the conference entitled "Opportunities for Women" is recognition that special attention needs to be paid to women in the energy workforce. The problem for women in the energy workforce is the same as for women in the general workforce, i.e., occupational segregation and its partner, lower wages.

The problem for women is briefly this: The ratio of women's to men's earnings has stayed constant at under 60%. In 1955, the median income of full time women workers was 64% of their male counterparts; in 1977 it was 59%. This increase in the earnings gap has occurred despite the steady increase of women into the labor market. In 1958, women accounted for 33% of the civilian labor force; in 1978, they made up 42%.[11]

This persistent male-female wage gap has two major causes. One, women are occupationally segregated into female intensive jobs, which are low paying, with limited opportunities for advancement. Two, the dramatic increase in women's participation in the labor force has resulted in a sizable group of women in entry level positions.[11]

Occupational segregation, the major culprit, results in lower wages. Women are crowed into a limited number of occupations, therefore, the competitive pool for an occupation is inflated. The consequences of an inflated competitive pool of workers is deflated wages. While the rapid influx of women in the labor market may be new, occupational segregation has a strong and consistent history. As of 1971, occupational segregation had not decreased since 1900, but increased by 1½ percentage points.[8] In 1979 the Commission on Civil Rights reported that occupational segregation has increased substantially since 1970. To illustrate, in 1976, ⅔ to ¾ of women would have had to change jobs to match the occupational patterns of majority males.[7]

To cite just a few more statistics to illustrate how women are tightly clustered in the labor market: One half of all women workers are in occupations that are more than 70% female. Women are 98% of all secretaries, 64% of all service workers, 95% of all household workers, less than 10% of skilled workers and less than 5% of top management jobs. Of the 14% of women in professional-technical jobs, 75% are either nurses or teachers.[3]

Women—Energy Workforce

Similar patterns are found for women in the energy workforce. A 1976 survey of recent science and engineering graduates found that females account for 29.1% of the new science and engineering majors, but only 8.3% of the energy-related science and engineering majors. When classified by occupation women make up only 6.7% of the energy-related occupations versus 19.3% of all scientists and engineers.[4] Another survey of doctoral scientists and engineers found that although 5.9% of all doctorates in mathematics were women only 2.9% were working in energy-related fields. In physical science the pattern is similar. Women make up 4.4% of the doctorates but only 1.8% are doing work in energy-related fields.[5]

After presenting devastating statistics that demonstrate the enduring and widespread unequal economic position of women there is good news. The problem may be awesome, but the solutions are simple. This optimism is based on the wisdom of a philosopher-educator, Paul Goodman. He brilliantly observed that most of us think that life is complicated and hard. We are wrong. Life is simple and hard. And so are the solutions for increasing opportunities for women in energy.

I would redirect our efforts away from theories that try to explain women's position in society to the simple and hard work of training and retraining women to fill the technical and professional jobs in energy and energy related fields. Let's not spend too much time concerned about math anxiety, fear of achievement, brain hemispheric activity or hormonal balance. These theories may be interesting, but too often they obscure the obvious. Our work is to simply get down to the basic work of training and retraining women in energy and energy related occupations. I know it can be done because it is being done.

One case in point. A technical institute in Massachusetts trains people for technical jobs in the electronics industry. Obviously, many of these jobs will be in energy or in energy related areas. This year over 20% of their students were women.

Women successfully complete the course work and are being placed in the electronics industry. A lot of the women don't stop with the initial training but seek jobs that offer further training and advancement. Before training these women were secretaries, switchboard operators and kitchen workers. This Institute's success is due to their recognition that there was a labor shortage in the electronics industry, and that women were prime candidates to fill these jobs. They made an organizational commitment to recruit and train women and then went on with the simple and hard work of doing just that. Once there is success a "referral system" starts. Positive results are seen and the word quickly spreads.

Success also is due to the fact that this is an effort based in the community, conducted at a local level. An analysis was made of the local labor market to ensure that there were jobs at the end of training. These jobs offer good pay, opportunity for advancement, and the course work is clearly practical and necessary to achieve the desired goal of a better paying job. Local guidance counselors were contacted by the school and their cooperation was elicited. The business community also was aware of the schools efforts. People will perform when there is good reason and environmental support for doing so.

Technical Training

These were specific examples, but there also is something happening at the national level. In 1976, 9.1% of the students enrolled in technical education were women. By 1978, this percentage has almost doubled, to a figure of 17.6%. Women in agriculture have grown from 10% in 1976 to 17.2% in 1978.[10] This demonstrates that there is a growing pool of women who will be trained to enter many energy related occupations.

A brief overview of the problem for women in energy was presented. More importantly the assertion was made that while solutions to this long-lasting problem may be hard they also are simple. Next a number of points are made to be considered when strategies for improving opportunities for women are discussed.

My first point is that training and retraining at the workplace should not be neglected when identifying opportunities for women. It has been estimated, not too precisely as yet, that between $4 billion and $100 billion is spent annually on education and training. Opportunities for education and training would allow the many women currently employed in the energy industry to enter more promising jobs in the same industry.

In the past, some employers have not seen the training of women as being cost effective. In the 50s and early 60s, there were fewer women in the labor market and those women were more inclined to leave the labor market to raise their children. Women who returned after several years absence had to be retrained, therefore many companies were hesitant to invest training money on female employees. But the late 60s and 70s witnessed both sociological and technological changes. Not only are there more women than ever in the labor market, but these working women are less inclined to leave after the birth of a child, or return more quickly. The labor force participation rate for all women with preschool age children was 44% in 1978, compared to the 1970 figure of only 30%.[5]

Another factor that changes the potential training investment is rapid technological change. New technologies require training and retraining of all workers. A male employee who is continuously employed in a high technology field is likely to need retraining as much as the woman who has taken a two year leave of absence to fulfill social roles. Increasingly, workers can expect training and retraining to keep their skill levels current.

Thinking Small

My next suggestion is directed at what has been called the "traditional educational delivery system" or non-employer based educational institutions.

In considering opportunities for women in energy I would urge educators to think small and to unite forces. By think small, I mean that educational institutions responsible for preparing students with entry level job skills should be aware not only of the national labor market but very familiar with the local market as well. The tools exist to do an analysis of the local labor market so that there can be some certainty that jobs exist for those students being trained. The reality of a job adds immeasurable credibility to any educational programs. Related to the "think small" suggestion is one to unite forces. Any educational program will be more successful if it has been developed with the advice and consent of local union and business leaders. The idea of community councils, comprised of representatives from unions, industry, and education, is to assist in the transition of education to work and to promote and facilitate retraining efforts.

All of these suggestions—to provide training opportunities to women currently employed in the energy industries, to think small and to unite forces—are predicated on a basic assumption.

This assumption is that it is in the self interest of educators, unions, and business to recruit, train, and place women into the energy and energy related industries.

All strategies to improve opportunities for women resolve around this central assumption. The work of expanding opportunities for women will be made much more difficult or will meet with failure, if it is not apparent to a company, or a union, or an educational institution, that it is in their self interest to train or recruit women.

Government Regulations

Government regulations for affirmative action and equal employment opportunities certainly provide one type of incentive to business and unions to recruit, hire and promote women. Another incentive will emerge if labor shortages are found. Women represent an important pool of talent which has traditionally been tapped when shortages have occurred. A study of employment trends in the high technology sector of Massachusetts is encouraging. Projected new hires for 1978–1983 within the high technology sector in Massachusetts are as follows: 12–22,000 additional junior engineers, 7–12,000 technicians, and 4–10 senior engineers will be needed.[1] A survey of Massachusetts companies showed unfilled jobs for electrical and mechanical engineers, computer sciences, electronic and computer technicians, computer programmers as well as projected additional needs in each of these job categories.[4] California shows the same pattern. An industry survey in that state last year projected that job openings in the technical category would triple in 12 months.

Another incentive that needs to be pointed out to employers is that women are good workers. An Institute for Social Research study of women and men on similar jobs found that women consistently produced more than men. The Armed Services experience with women has been favorable, also. Women on active duty are being promoted at the same or a higher rate than men. In all services, women score higher on the entrance test than their male counterparts. And, interestingly, the marginal costs of recruiting high quality men is enormously more than that for recruiting women. In the army the rate for recruiting high quality men is $3,700 and for high quality women it is $150.[8]

Women in the labor market have as much education as their male counterparts. Some see obstacles for women in technology and science because of a weakness in mathematics. This is not accurate either. Females do as well in mathematics as males, *if* they have taken the same courses. Too often girls are not encouraged or expected to take mathematics, however.

There are incentives for unions and educational institutions to recruit women. To unions, many of whom are experiencing declining memberships, women represent potential members. To educators, women are an important resource in an age of declining enrollments.

SUMMARY

Promoting opportunities for women in energy will not be easy. There is a history of occupational segregation of women that is prevalent as much, or more, in the energy industry. Conventional energy producing corporations, including those now developing new technologies such as oil shale or coal liquefaction, have a tradition of male domination. Women have met stiff resistence in the construction industry and in the coal mines from the industry, unions and their fellow workers.

Research also suggests that women are not served by energy development and that their economic status in energy boomtowns may actually diminish. Women do not share in the higher wages stimulated by these energy boomtowns, but they fall victim to the higher cost of living.

But, again, the solutions are not complex; they are simple. Girls and women need to make adequate educational preparation for careers in the energy field. This means that girls and women need to be encouraged by teachers, counselors, and parents to take math and science. Employers and unions need to be gently reminded that there are government regulations requiring that equal employment opportunity and affirmative guidelines be followed. Of equal importance is that employers, unions, and educators see and understand the benefits to be gained from recruiting and hiring women. Vocational and technical educators need to be sold on the notion of sex equity. Technical assistance should be provided to vocational and technical educators so that effective recruitment and training programs for women in energy can be developed.

As much as possible, efforts to increase opportunities for women in energy should be made at the local level and should involve the appropriate community members. Social change is more powerful if it starts at the community level rather than being imposed from top.

REFERENCES

1. Burke, T. High Technology Enterprise in Massachusetts, Its Role and Its Concerns. Report prepared for the Commonwealth of Massachusetts, Boston, October, 1979.
2. Ferris, A. L. *Indicators of Trends in the Status of American Women.* New York: Russell Sage Foundation, 1971.
3. Martinez, Gail. "Women Working for Energy". Energy Resource Development: Implications for Women and Minorities in the Intermountain West. U.S. Commission on Civil Rights, November, 1978.
4. Massachusetts High Technology Council, Inc. Results of Survey on Human Resource Needs. Prepared by Coopers and Lybrand. January, 1980.
5. Norwood, J. & Waldman, E. "Women in the Data Force: Some New Data Series". Paper presented at the Annual Meeting of the American Statistical Association, Washington, D.C., August, 1979.
6. Rall, J. E. *Energy Related Scientists and Engineers: Statistical Profile of New Entrants into the Work Force, 1976.* Report to U.S. Department of Energy, Contract No. EY-76-05-0033, October, 1978.
7. U.S. Commission on Civil Rights *Social Indicators of Equality for Minorities and Women,* Washington, D.C. April, 1978.
8. U.S. Department of Defense. Office of the Assistant Secretary of Defense, *Use of Women in the Military.* Second edition, September, 1978.
9. U.S. Department of Energy. *Energy Related Doctoral Scientists and Engineers in the United States 1975.* DOE/IR-0033, November 1977.
10. U.S. Department of Health, Education and Welfare, Office of Education. Bureau of Occupational and Adult Education. Summary Data, Vocational Education Program Year 1976 and 1978.
11. Women's Bureau, U.S. Department of Labor. "The Earnings Gap Between Women and Men", 1979.

Linkage Efforts Among the States

Edith M. Petrock, Education Commission of the States, Denver, Colorado

BACKGROUND

Linkage building is central to the *purposes*—and the *structure*—of the Education Commission of the States (ECS). Linkages are built among persons having different professional and political perspectives; among the various states and the federal government; and among the myriad of educational and state-based political organizations and associations. However, prior to discussing the application of those linkages to energy and/or work-related education, I will briefly describe the Commission, recognizing the fact that it is not yet a household word, even among its natural constituency.

Approximately 15 years ago, James Bryant Conant wrote a short book, entitled *Shaping Educational Policy,*[1] in which he

1) acknowledged the fact that educational decisions are made in the political arena, and not necessarily by those with the best available information;
2) acknowledged the fact that education is ultimately a state responsibility and criticized the states for their lack of enlightened leadership in educational matters; and
3) suggested a mechanism through which educators and political officials—from all or many states—could work together to improve state-level educational decision making.

With the assistance of former Governor Terry Sanford of North Carolina, and the endorsement of the National Governors' Association, the Education Commission of the States was established in 1966 by interstate compact to further working relationships among state political officials, educators, and lay citizens for the improvement of education at all levels. Presently, 47 states and three territories are members of ECS. The Commission serves as a forum, resource, and catalyst. It provides information on state-related education activities and, when appropriate, suggest options and alternatives to meet specific state needs. The Commission also serves as a liaison between the states and federal government.

Seven representatives from each member state constitute the operating body of the Commission. Commissioners include the governor, two members of the state legislature selected by their respective houses, and four persons selected by the governor who are active in education. In addition, ten representatives of federal agencies and additional representatives of other educational organizations serve as non-voting Advisory Commissioners. A full meeting of all Commissioners takes place annually, and one Commissioner from each member state serves on the ECS Steering Committee which meets regularly between annual meetings to provide policy direction.

The Commission is located in Denver, Colorado, and has a staff of about 160 in three departments and two centers, and the Office of the Executive Director. The departments and centers are Elementary/Secondary Department, Postsecondary Education Department, Research and Information Department, the Center for Evaluation, and the Center for Education Finance and Law.

Three unique characteristics of the organization's structure give ECS the capacity to provide programs and services in education beyond that of any other organization. First, the Commission is the only organization that, by its very makeup, brings *together political and educational decision makers*. Second, ECS deals with the *entire educational process from early childhood through lifelong learning* and, thus, is able to take a comprehensive approach to the education needs of Americans. Third, ECS programs are aimed at both the *public and private sectors* of education.

Energy and Education

During the past several years, ECS has engaged in a number of activities which involved either energy and education concerns or the transition from school to work. Although ECS has not yet addressed the intersection of these spheres, there are some tentative plans to do so in the future. In order to enable people to utilize the linkages which have been established, I will give you some information on what ECS has done in the two areas of energy and work and what is planned next.

ECS began its involvement in energy issues n 1973–74, when state-level reactions to energy supply curtailments were surveyed and published.[2] In 1977, the National Assessment of Educational Progress (NAEP) administered a well-publicized survey of knowledge and attitudes about energy among 26- to 35-year-old Americans which suggested that young people lack sufficient knowledge to make informed decisions about energy-related issues.[3]

In 1978, ECS received a grant from the U.S. Department of Energy to determine the status of state policies and practices regarding elementary and secondary level energy education among state education agencies, energy offices, governors' offices and legislatures. The conclusions, published in *The Status of State Energy Education Policy*,[4] included the following:

1) Interagency communication and cooperation regarding elementary/secondary energy education is not extensive. Where it does occur, it tends to occur between state education agencies (SEA's) and state energy offices (SEO's).
2) Most of the responsibilities for elementary/secondary energy education are assumed by SEA personnel and, to a lesser degree, by SEO personnel. Many SEA's have assigned energy education to an environmental education specialist.
3) Many state energy education programs are funded with federal monies.
4) Most elementary/secondary energy education programs are designed for integration into existing curricula, tend to offer generalized rather than region-specific programs, and are geared to science and social studies classes.
5) Many legislative respondents did not see a need for legislative involvement in energy education; gubernatorial respondents often felt their involvement was already occurring through education agencies and energy offices.

Based upon the findings of the state energy education policy survey, an eleven-member National Energy Advisory Committee, chaired by the Honorable Richard Lamm, Governor of Colorado, recommended the following policies:

1) that schools have an urgent need to include energy-related topics in the curriculum at all levels, preferably as part of an integrated, comprehensive energy education conservation program?
2) that there be measures to increase inter- and intra-state level cooperation and communication among agencies involved in K-12 energy education. State education agencies, and interested officials should work cooperatively to develop and implement comprehensive K-12 energy education programs unique to the special needs of each state;
3) that there be development of policies at the state level that include provisions for allocation of funds to state education agencies and/or state energy offices, as well as use of local funds by local education agencies, for development of comprehensive K-12 energy education programs;

4) that state education agencies, local education agencies, and individual schools (public and private) consider ways in which energy education efforts can be enhanced and further supported under authorities of existing federal education legislation;
5) that policy-makers consider ways in which institutions of higher education can contribute to the development of "energy literate" educators.[8]

These recommendations were officially adopted by ECS at the 1979 annual meeting, and are available upon request.

As a constructive reaction to the survey results and policy deliberations, ECS offered its services to the Energy and Education Action Center, USOE, to facilitate the formation of an interstate network composed of representatives from state education agencies, state energy offices, regional and central offices of the U.S. Office of Education and the U.S. Department of Energy, and various agencies and programs involved in energy conservation and education. The purposes of the network were to 1) build upon state capabilities to address energy issues and 2) foster intra- and inter-state communication and cooperation.

The First Interstate Energy and Education Network Conference was convened in Denver, Colorado, on March 29-30, 1979. Based upon the comments made during the conference and from written remarks on the evaluation forms, the March meeting was an unequivocal success. Participants felt that the conference goals were met: education roles in energy and conservation were examined, conservation and its relationship to instructional programs were discussed, and avenues for communication and cooperation among participants and agencies were initiated and/or strengthened.[9] A series of regional workshops followed the national forum, and a second national meeting was anticipated for 1980. However, the current lack of resources to support this inter-state/inter-agency network has left a serious vacuum precluding the necessary communication and cooperation among persons responsible for developing and implementing policies and programs promoting energy-related education and conservation at the state level. Furthermore, these persons are growing disillusioned over the apparent lack of sufficient federal commitment to work with the states as partners in addressing a national crisis. This is particularly discouraging at a time when the network should be *expanding* its mission to address dissemination needs in vocational and technical training, as well as other areas.

Meanwhile, we are continuing our energy education policy activities, gearing up for the next phase which will concentrate on working with seven pilot states to develop and implement state-specific energy education policies and programs and to work with the Energy Education Advisory Committee to refine the energy education policy recommendations previously developed.

In addition to these energy activities, the Commission has a long history in education and work, much of which has been in career education, focusing on alternative methods for linking employers, labor leaders, government officials and educators to more effectively address state and federal policy issues and to develop alternative state level legislative approaches.

Based upon this work, an expanded effort is under way to bring together this same mixture of interests to address a broader set of issues than career education, such as

- planning to meet the long range education needs of young persons during and beyond the 1980's,
- planning for a better match between the labor supply and demand, focusing on changing job requirements, and
- examining the implications of technological advancements.

As these activities are currently in the development and early implementation stages, the best source for additional information is Dr. Gene Hensley, the project director. He can be reached at the ECS number: 303/861-4917.

SUMMARY

I'd like to conclude with the reminder that a variety of linkage mechanisms are in place; it is not always necessary to create new ones. As you consider your next steps, particularly as they relate to state level educational policy decisions, take advantage of the Commission and its existing networks. Feel free to contact our staff with your questions and suggestions; send us copies of your publications so that we can make them known to persons who request related information; and, most importantly, let your state commissioners know your concerns, as our activities are largely determined by the priorities which they determine. You can—and should—have a voice in that process.

REFERENCES

1. James Bryant Conant, *Shaping Educational Policy* (New York's McGraw-Hill Book Company, 1964).
2. Doris M. Ross, *Education's Response to the Energy Crisis: A Survey of the States*, (Denver: ECS, February, 1974).

3. NAEP, *Energy—Knowledge and Attitudes: A National Assessment of Energy Awareness Among Young Adults,* Report No. 08-E-01, (Denver: ECS, December, 1978).
4. *The Status of State Energy Education Policy,* (Denver: ECS, March, 1978).
5. *"Policy Issues in K-12 Energy Education,"* (Denver: ECS, 1979).
6. Gary R. Smith, *Building an Interstate Energy and Education Network: A Conference Report,* (Denver: ECS, June, 1979).

Industry and Linkage Building

George H. Lawrence, President, American Gas Association, Arlington, Virginia

Speaking for the industry which provides our most dominant source of energy, I do have a few points I want to make on my own, and others, which, I hope will drive home some of the thoughts and recommendations the contents of this work has treated which will enable us—together—to help solve this nation's number one problem—energy. This is a problem that cries out for a better linkage between industry, educators and the government.

It is energy which is at the heart of our most urgent domestic problem—inflation. And it is energy which is at the heart of the most urgent international problem, the survival of the Western World as we know it.

For the gas industry to continue to make its essential contribution to the nation's energy needs, to assure that there will be an expanding availability of gaseous energy, we must have an expanding, well-trained and competent work force. This calls for linkages of the first order.

If there is any industry which understands and appreciates linkages and education (with a small "e"), it is the gas industry.

It will soon be three years since President Carter in his energy message talked about everything but gas energy. In fact, we were practically written off as having any role to play in solving the energy problems facing our nation then and—in many respects—still confronting us. I need not tell you how disturbing this statement of national policy was to us.

This was the devastatingly mistaken role assigned a vital industry, one which provides 25 percent of all energy consumed, and accounts for 33 percent of all energy domestically produced. Gas is used in over half of the nation's home and commercial establishments, serving more than 46 million customers.

American industry and agriculture also depend on gas more than any other form of energy. Gas accounts for about 40 percent of energy consumption in these two sectors. Moreover, the nation has a major financial commitment to natural gas, with a total utility industry and consumer equipment investment estimated to exceed $115 billion. Half of this investment is represented by over 1 million miles of underground gas pipelines and mains throughout the U.S., and half by a variety of appliances and industrial gas-using equipment.

I am pleased to say that since the President's message in 1977, the situation has been reversed, not only insofar as the Administration is concerned, but also in regard to how the public in general sees us. We now hear phrases such as "This is the Golden Age of Gas," or as one financial house termed it, we are now enjoying "The Renaissance of Our Industry." This has taken a massive linkage-building effort, not only with government, but with many of our nation's opinion leaders and the public in general, and even some organizations and groups who were formerly open opponents.

So I can attest to the need for a vigorous and continuing effort. Each of us has an essential role in arriving at solutions and policies which will avert the dangers inherent in the energy supply shortages and a dependence on imported oil.

The gas industry and other energy industries have been working to build an understanding with all our publics. Obviously, we haven't done as well as we should. But I submit that linkage building, or communications, if you will, is a two-way street. It requires listening as well as talking. I believe we have learned some ways to do better in the future.

Business and industry have been among those complaining the loudest that not only government, but students and teachers don't understand business—that they don't appreciate what the private sector does or what its problems are. There has been a lot of lip service in support of better mutual understanding, unfortunately, not a great deal more. All of us carry around stereotypes of each other—or as Walter Lippman termed it, "pictures in our heads." And many of the pictures, I suggest, are out of focus. Understanding of the governmental policy makers and the lawmakers is important. And I feel confident that our efforts to gain a better understanding of the essential contribution which gas energy can and must make to our nation's total energy mix have been moderately successful. The turn-around I discussed is demonstrated by the passage of the Natural Gas Policy Act in late 1978 which removed 25 years of unworkable federal field price controls.

There is greater public understanding and appreciation—as witnessed by the waiting lists gas companies have for people who want to switch to gas, whereas a few years ago there were moratoriums on new hook-ups—as well as the improved gas supply situation which has enabled our industry to replace 435,000 barrels per day of foreign oil in 1979.

These changes have come about by building a confidence in the future of the gas industry and through growing support of the conservation ethic in this nation. As an industry, we support the position that we need all dependable forms of energy—in greater abundance—gas, coal, oil, and electric power. But we also argue strongly that if national conservation policy is to be anything more than an illusion, such policy must be based on the most efficient use of the various energies available to us. In my opinion, the words "efficiency" and "conservation" are synonymous, in fact, interchangeable.

Speaking even more directly to the subject of this book, the renaissance of the gas industry I mentioned a while ago will provide many job opportunities. *You* are interested in providing the work force that the energy industry needs. We are, to the same degree, concerned with finding and employing qualified personnel to enable the gas industry to fulfill its obligations to all Americans.

It is our responsibility to let the educators know what we need. We certainly do not wish to intrude upon your prerogatives as educators, nor do we question your expertise. But I think input from industry as to the structuring of curricula would benefit both of us. We, as a vital U.S. industry and you as those training the work force industry must draw upon, have much in common.

On the production side, when the numbers are totalled, it becomes obvious that the number of drilling rigs needed to produce the natural gas planned for will require a doubling of the number of rigs in the next five years. Today we have 2,500 rigs, we need 5,000. This, of course, means a doubling of the work force, the technicians, the petroleum engineers, the computer force, etc., needed to man and support these rigs.

The human resource requirements of the gas industry are not limited to the more mechanical areas alone. With increased automation, there is need for many more programmers. The technical and administrative staffs must expand at a commensurate rate. And all must understand basic economics. It is up to us to let you know what we need, and we are trying. Not only is a competent work force needed for a growing gas industry, but those hired in the surge of the mid-50's are nearing retirement. They must be replaced.

Impressing upon young people the need for energy conservation and realistic energy production goals is the groundwork for responsible citizens of the future. Even more so, they will become supporters of the ethic and be interested in contributing to its fulfillment. In all energy industries there will be jobs for those who want to contribute, from research in the laboratory to the installation of insulation and energy saving devices. It is at this level that the respect for conservation is impressed upon the adults of tomorrow.

The gas industry has as one of its top priorities the identification of its human resource needs for the next decade. As part of this assessment, we are determining the resources currently in place to develop the work force skills that will be required. Our commitment to education and government is that once the voids are identified —and these may be voids in resources or the location of resources in relation to the need or the population—we will work with the appropriate institutions to develop curricula and to corral the funds needed to achieve these goals.

Practically all A.G.A. gas company members—300 in all 50 states—have extensive programs for training in technical and skill areas. Such programs encompass training in: newly hired general utility worker, mechanic (various levels), inspector (various levels); supervisor; welding; shoring; customer field representative; maintenance; underground mains and services; meters and appliances. Such training gives the company an opportunity to educate the new employees as to practices and policies and to accomplish upward mobility for personnel under controlled manpower development standards. An example of technical and skills training is Consolidated Edison Corporation of New York, where 47 courses in technical training for gas servicemen and mechanics are offered.

The section in the A.G.A. Gas Industry Training Directory for technical training shows 27 gas companies, 29 manufacturers, 2 consultants, 2 universities and 2 regional gas associations listing 356 courses to be shared with other gas companies.

The gas industry also must strengthen ties with institutions of higher education. A beginning has been made. Current projects involve the Universities of Colorado, Maryland, Wisconsin, Illinois Institute of Technology, I.G.T.; Virginia Commonwealth University; University of Texas and Northeastern University.

A good example of the linkage between educators, government and industry is the Rate Course for State and Federal Regulatory personnel. The University of Maryland, with assistance from the gas industry, formulated the program and the course now is an annual training program, and it works.

I'd like to describe one outstanding program by one of our members which I think demonstrates most of the things we have been talking about.

The Northern Natural Gas Company has developed a weatherization program to be used by their companies to make it possible for the elderly and disadvantaged to conserve energy. This program pulls together resources in the community that deal with weatherization and equipment and coordinates their activities.

The curriculum materials and training design have been developed by Northern Natural Gas and are made available in a unique training package. The customer companies, along with Northern Natural Gas, meet with local agencies that have been responsible for weatherization to present this package and to provide assistance. The training component of this package does not only provide weatherization skills for the young man and woman who takes this training but they also acquire a trade and social skills which can be utilized beyond this weatherization activity.

This program also has the added advantage of pulling together community organizations that for many years have been alienated from utility companies and has demonstrated the ability of utility companies and community agencies to work together in a substantive and pragmatic way.

The two models in Omaha and Des Moines have been highly successful and the national community action agencies' executive organization has asked its members in its monthly newsletter to avail themselves of this opportunity to work with utility companies whenever it is available.

There is a truly outstanding example of the benefits which can result from focusing the combined talents of government, industry and academia on the subject of energy. The example I have in mind is the highly important recent analysis of U.S. energy use, developed under the auspices of the Energy Productivity Center of the Mellon Institute—a department of Carnegie-Mellon University of Pittsburgh, Pennsylvania. The cost of this project was underwritten by government, it benefited from inputs by industry, and was produced by academics. All these sectors worked together in a cooperative and productive manner.

This study, entitled "The Least-Cost Energy Strategy," indicates that if a truly economic energy policy had been followed in the United States for the last 10-15 years, the total consumption of energy in the U.S. in 1978 would have been 24 percent less. However, there would have been no loss in the amount of benefits or services, despite the fact that far less energy would have been used.

Under the least-cost scenario, gas use would have been increased 4 percent, while overall use of oil would have been reduced by 30 percent. As a result, consumer costs of services would have been significantly lower, there would have been a positive effect on the U.S. environment, and America's national security would have been enhanced because a least-cost strategy would have allowed us to cut our oil imports in half. It should be noted that this least-cost energy strategy calls for increased gas use in addition to the very large amounts of gas currently being utilized in the United States.

This I submit, represents effective linkages of the first order between industry, government and academia.

A quotation attributed to Thomas Henry Huxley, the nineteenth century English scientist and educator, seems a fitting closing comment. Mr. Huxley said:

> "Perhaps the most valuable result of all education is the ability to make yourself do the thing you have to do, when it ought to be done, whether you like it or not; it is the first lesson that ought to be learned; and however early a man's training begins, it is probably the last lesson that he learns thoroughly."

Improving Linkages among Governmental Organizational Entities

Wilton Anderson, Director, Energy and Education Action Center, U.S. Office of Education, Washington, D.C.

INTRODUCTION

Linkages as defined by this paper, means collaboration to achieve mutually agreed upon objectives between two or more operating units within the Federal government. Governmental entities of course are organizational components that exist as a result of legislative sanction or by administrative initiative. The term "improving" is intended to convey the positive outcomes of increased collaboration, however motivated, brought about by two or more discrete governmental entities.

Inherent in the topic which this paper addresses are two questions: are linkages among discrete governmental entities possible and if they are possible, to what extent can they be improved. These questions seem appropriate by virture of the fact that they relate directly to the need for an across-the board, government-wide education-focused response to our energy problems. Such linkages are not likely to be accomplished in the absense of an explicit policy directive with clearly stated mandatory or compliance elements. The quest for linkage is further complicated by the type of organizational instability brought about by the recent establishment of two key federal agencies: the Departments of Energy and Education. In this context, organizational behavior merits brief treatment prior to a fuller discussion of improving linkages.

The body of literature on organizational dynamics and behavior is replete with findings by behavioral scientists which suggest that linkages among organizational entities are difficult to realize without an official mandate or mutual incentives. That is, given the nature of organizations, given their internal and interpersonal dynamics, and the circumstances which contribute to their establishment, few societal conditions surface that are of such levels of criticality that linkages among organizational entities can be effected on such a basis alone. Rather linkages would still require official sanction or appropriate incentives.

Applying this axiom to improving linkages among governmental entities as such collaboration relates to energy education, students of organizational behavior would postulate that the desired linkage would be very difficult to realize if left entirely upon organizational perceptions regarding the criticality of the nation's energy dilemma and its relationship to education.

The social scientists would argue that desired linkages would be more dependent upon official sanction, mandate, or incentives than upon organizational perceptions of the level of criticality of the energy/education situation. When the stability of organizational entities is undermined by bureaucratic reorganizations, shifts in budgetary priorities and key personnel, desired linkages become even more difficult to realize.

Individuals—Critical Variables

An examination of the current organizational instability occurring in many federal agencies, notably the Departments of Energy and Education, would lead to a pessimistic conclusion regarding prospects for viable linkages. Similar analyses are given by behavioral scientists who factor in the many human dimensions which make bureaucracies somewhat less than perfectly tuned machines. To exclude individuals as critical variables from an examination of organizational operations is as erroneous as assuming that the external environment and internal structures are static and constant.

As one pair of theorists stated, "OD (Organizational Development) uses the individual as the basic organizational unit for the type of *change* and *growth* that will ramify eventually into activities that will enable the enterprise to fulfill its specific mission" (emphasis added).[1] The dynamics of individuals must be considered concurrently with the endless fluctuations in organizational patterns, priorities, and personnel. Because a linkage appears logical or appropriate, or even inevitable from a detached programmatic standpoint is no guarantee that interface will occur. Quite the contrary: given the jurisdictional overlap which can be easily derived from the nebulous terminology of bureaucratese, and the pressures for fiscal constraint confronting all federal agencies, interaction may be sacrificed for isolationism.

Despite the potential benefits and service enhancement which collaboration offers, shared objectives though necessary, are not sufficient incentives for shared effort. This post-Proposition 13, post-Watergate period fosters an environment that constantly raises the question of organizational legitimacy. This comes often in the form of an actual challenge to the need of the organization to survive.[2]

An Interactive Process

The saliency, even the criticality of mutual goals is obscured by the phenomena of linkage perceived negatively as a burden, not an opportunity. Again the consideration has a personal as well as an organizational dimension. If incentives for cooperation prove insufficient, then either the goal per se or the commitment of those involved might be questioned. It cannot be over-emphasized, however, that "environment support" appears as an especially important correlate of greater effectiveness in organizations.[3] At the Federal level this support is indexed by budget outlays, personnel resources, legislative activity, official decree, the magnitude and effectiveness of constituencies, and not incidentally, linkages. Linkage is a programmatic attribute in two key respects: the organizational entity establishes a network which enhances and expands support and resources directed at the attainment of specific objectives while simultaneously receiving information, evaluations and recommendations, which upgrade decisionmaking and task outcomes. In essense all parties furnish inputs and outputs in an interactive process which emphasizes dialogue, exchange, innovation, and cooperation. Where the goal is educational as ours is linkage is indeed a prerequisite in any viable program scenario. Coupled with a topic as multifacited as energy, the volume of communications required rises exponentially. The momentum for linkages is greater than even the integration of these two dynamic fields—energy and education—would lead us to expect. For we are striving to advance knowledge and awareness which is fundamentally at odds with the conventional wisdom that equates material wealth with fulfillment and the corollary which measures individual worth in terms of consumption. These and related attitudes, however unconscious or subliminally perceived, were nutured during an age in which resource exploitation, not preservation, was the norm. The "link" with future resource needs, not to mention aesthetic and environmental concerns, was seldom made. Hence, the sheer magnitude of the GNP became a principal indicator of national progress and fitness. Energy efficiency in production was not ordinarily considered for resources were generally conceived as infinite or at least imponderably large. The pervasiveness of this orientation reflects the linkage tasks ahead of us. Conservation requires concerted efforts by the government and private sector alike to decrease the slope of our resource depletion curves before growth, exponential consumption, in short, "business as usual" makes it impossible to do virtually anything in the usual manner. Effective comprehensive networking and collaboration will enhance our level of preparedness, facilitate discourse and discovery, and equip students with the cognitive skills needed to make our transition to an energy independent nation less difficult.

Mounting Societal Specialization

Above and beyond the question of prevailing patterns or behaviors is the mounting specialization of society. Nowhere is this more patently obvious than in the management and structure of Federal departments. Interface, interaction, shared responsibilities and mandates, and informal operating mechanisms are so pervasive that some degree of linkage is virtually a universal property. One theorist summarized it this way:

> "Everything is related to everything else, though in uneven degrees of tension and reciprocity. Every unit, organization, department, or workgroup takes in resources, transforms them, and sends them out, and thus interacts with the larger system."[4]

If the impetus for linkage brought about by program compartmentalization is to be held in proper perspective, however, it should be recognized that this very feature of our present system has a substantial "drag" effect on programmatic interface efforts. As the governing system becomes increasingly specialized the nature of its individual elements becomes increasingly obscured and esoteric.

Although bewildered private citizens are perhaps most often the victims of the cycle of telephone buck-passing, program personnel are by no means immune. Linkage requires a shared commitment to mutual goals and objectives, otherwise the collaboration may be largely a formality. It has been reported that a joint environmentalist-industry group, The National Coal Policy Project, does "not want to deal with ways to control sulfur dioxide emmissions."[5] This may be an excellent example of what happens when a group is forged with members possessing competing, even mutually exclusive priorities: confrontation and compromise are avoided, and the agenda is truncated. When the sum of the missed opportunities and mismatches is compared to the total of all linkages, a clearer picture of the inherent difficulties emerges. The sheer magnitude of compartmentalization dictates that an organizational entity with a substantial information base will in all likelihood be in a superior position with respect to prioritizing and effectuating linkages. Such a program is also quite favorably situated to link people in search of government services, resources or expertise, since the more knowledge it has of external activities the more accurate its information dissemination functions. Much of this knowledge is derived from data flows, either formal or informal, oral or written, direct or indirect. Regardless of form, these communicative transactions generally reflect either an existing linkage relationship or an attempt to initiate one.

A point worth considering here is the positive impact which personal face to face forums can have on linkage efforts. Firsthand briefings and planning sessions concretize and de-mystify the abstract jargon of organization charts. The interactive process acts as a potent antidote to the dysfunctional preconception that every agency is an autonomous self-contained organism bearing no resemblance to any other. Professional associations developed as a result of linkage should reinforce the programmatic stimulus for collaboration, provided the incentives for all parties are genuine. In a setting of indirect electronic and print communication channels, meetings stand out as salient events that broaden interdepartmental collaboration in a manner that no documentary mandate alone can. The distinction may appear elemental, but it represents the difference between theoretical and actual cooperation, and that can make all the difference in the world.

SUMMARY

This has been all too brief a treatment of a topic which demands a much more exhaustive examination. It should be clear that linkage is an intrinsic characteristic in most governmental initiatives. At the same time, it is no less apparent that there is an imposing panoply of inhibiting factors and obstacles which prevent linkages from developing fully, or even being considered. Some of these obstacles are organizational, others personal, still others legal or technological.

Improving linkages requires a systemic approach in which all organizational resources are employed in concert to minimize obstruction and facilitate interaction. Nothing in the organizational environment is perfectly static: structural configurations, legislative mandates, and administrative priorities are all subject to change, complicating or even terminating existing linkage mechanisms, but also creating new opportunities for innovative collaborative strategies. Variables totally external to our government and our society exert influence on the direction and intensity of actions geared toward marshalling program efforts across departmental boundaries. Certainly this has been true with energy issues.

The social, economic, technological, political, and ethical implications of energy systems require a comprehensive analysis and programmatic response which cannot prudently be confined and contained in a single department, or even several. Education's role, like all others, must reflect a sense of the magnitude of the problem, the destructive effects of skyrocketing fuel prices on instruction in the nation's schools, and the urgency of providing knowledge and skills to students that will enable them to overcome our precarious dependence on nonrenewable fossil fuels.

The oil embargo of 1973 was a cold shower for a society oblivious to the vulnerability of its own relative affluence. By working together, government agencies, students, and educators can reduce the likelihood that a more severe rite of passage occurs in the future. It is these sets of circumstances and within the contextual framework of this paper that the Education Department's Energy and Education Action Center has evolved.[6]

Will it prove to be a timely and appropriate mechanism to improve linkages among governmental organizational entities? Only time and accomplishments will provide the answer. To date, both time and accomplishments suggest that the Center is on target. If the National Conference on Meeting Energy Workforce Needs, sponsored by the Energy and Education Action Center in cooperation with federal agencies, professional organizations, and other governmental and private entities, is indicative of the results of effective linkages and collaboration, then future prospects are highly optimistic. Indeed, as reflected in this proceedings which comprise the main body of the Energy Workforce Conference, the inherent linkage requirement of the Center's overall mission: "To promote all phases of energy education-related activities on an interagency basis by drawing upon all relevant Federal, State and local resources to assist educational clientele in implementing energy plans" is far along the road to full realization.

REFERENCES

1. Samuel A. Culbert and Jerome Reisel, "Organization Development: An Applied Philosophy for Managers of Public Enterprise," *Public Administration Review* (March/April 1971), p. 161.
2. Michael E. McGill and Leland M. Wooten, "Management in the Third Sector," *Public Administration Review*, (September/October 1975), pp. 444/55.
3. Michael Cohen and John N. Collins, "Some Correlates of Organization Effectiveness," *Public Personnel Management* (November-December 1974), pp. 392–99.
4. Charles Perrow, "The Short and Glorious History of Organizational Theory," *Organizational Dynamics* (Summer 1973), reprinted in *Readings in Organizations*, James L. Gibson, John M. Ivancevich, James H. Donnelly, Jr., editors, (Dallas: Business Publications, Inc., 1976).
5. "Sulfur Dioxide Issue Shunned by Coal Project," *Energy Users Report*, No. 346, March 27, 1980, p. 19.
6. Wilton Anderson, "EEAC Develops Regional System," Energy Conservation/Education INFORMATION BULLETIN, Winter 1980, pp. 1–2.